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THE

MINING INSTITUTE

OF SCOTLAND.

TRANSACTIONS.

Vol. XII.—1890-91.

HAMILTON:
PRINTED BY W. NAISMITH, CAMPBELL STREET.

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THE MINING INSTITUTE OF SCOTLAND.

THIRTEENTH ANNUAL MEETING,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON,

24th April, 1890.

JOHN M. RONALDSON, Esq., President, in the Chair.

The minutes of the last General Meeting were read by the Secretary, and confirmed.

COUNCIL'S REPORT.

The SECRETARY read the report of the Council as follows :—

This, the Twelfth Annual Report, reviews a year's proceedings, which are, on the whole, satisfactory. There has not been the increase in membership that characterised former years; but the number with which the year began has been maintained.

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There were 503 on the roll at the beginning of the session; 43 were added; 13 resigned; 3 died; and 27 were struck off on account of non-payment of subscription, leaving 503 at this date.

It will depend on the members themselves whether or not this membership is to be maintained merely, or, by the exercise of a little influence by each individual member, largely increased. There seems to be no reason why a material advance should not be made, when it is borne in mind that in Scotland alone there are about 600 collieries and works producing mineral.

The attendance of members at the general meetings has been steady. The interest and value of the discussions upon the papers read depend on a good proportion of the members being present and taking part. In the case of those who reside at too great a distance from the places of meeting to admit of their attending, they have an opportunity of sending their contributions in writing; and the Council would recommend that this be taken advantage of still more than is done at present.

An important part of the business of the Institute for the year was the preparation and production of the Report of the Committee on Coal-Cleaning, which describes and illustrates numerous examples of various systems of coal-cleaning in England, Wales, and Scotland. The expenses connected with the visits of the committee to the several collieries, and the cost of the numerous plates illustrating the report, have necessarily amounted to a large sum—£280 9s 9d; but it is confidently believed that the report will prove of great practical value to the members; and already a considerable number of additional copies have been sold in this country and America.

The papers read during the session have been quite equal in point of quality and interest to those of past years. The following is a list of the papers which, with the discussions thereon, have been printed in the Transactions:—

Recent Development in the Application of Electricity to Mining.
Gas-Fired Boilers.

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Petroleum or Naphtha Engine.
Air Vessels.
Lightning entering Pit Workings.
Pit Ponies; their Feeding and Management.
Carriage for Self-acting Inclines.

The customary annual excursion, to a structure of such world-wide interest as the Forth Bridge, then approaching completion, attracted the largest number of members that the Institute has yet had at any of its summer meetings.

The following is a list of the donations received during the year :—

Donor.	Donation.
Ralph Moore, ...	... Sum of £2 11s for Books for the Library.
The Publisher, ...	... Potts's Mining Register and Directory.
J. M. Ronaldson, ...	... Report of Inspector of Mines for West of Scotland for 1888. List of Plans of Abandoned Mines, 1889. Mineral Statistics, 1888. List of Mines Worked, 1888. Report on Explosion at Hyde Colliery, 10th January, 1889.
Secretary of State, ...	... Reports of the Inspectors of Mines for 1888; two Copies.
Herbert W. Hughes, ...	... Paper on the Thick Coal of Staffordshire.—*By the Donor.*
J. B. Atkinson, ...	... Handbook to the Industries of Newcastle and District, 1889.
Albion T. Snell, ...	... The Electrical Distribution of Energy over Extended Areas in Mines; four copies.—*By the Donor.*
C. M. Percy, ...	... Colliery Machinery; two copies.—*By the Donor.*

There have been Ten Meetings of Council during the year.

In addition to the Transactions and current Mining Papers got in exchange, the following Books and Pamphlets have been added to the Library during the year 1889-90 :—

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I. BOOKS.

The Industries of Scotland, 1869, ... *David Bremner.*
Solutions to the Questions set at the May Examinations of the Science and Art Department, 1881-1886 : Pure Mathematics, stages I. and II., ... *Thomas T. Rankin.*
The New Tay Bridge, 1889, ... *Crawford Barlow.*
Handbook to the Industries of Newcastle and District, 1889, ... *Edited by Wigham Richardson.*
Report of Coal Cleaning Committee, 1890, *Mining Institute of Scotland.*
Mining Royalties and their effect on the Iron and Coal Trades, ... *W. R. Sorley, M.A.*
Chemical Technology, ... *Edited by Groves and Thorp—Vol. I.*
Fuel, 1889, ... *Mills and Rowan.*
Illustrated Catalogue of the Rand Drill Company, New York, U.S.A., 1889, ...
The Gold Fields of Victoria : Reports of the Mining Registrars for the Quarter ended 30th Sept., 1889.
Annual Report of the Secretary for Mines for Victoria on the Working of the Regulation and Inspection of Mines and Mining Machinery Act during the year 1888. ... .
The Severn Tunnel : its Construction and Difficulties, 1888, ... *Thomas A Walker.*
Reports of the Inspectors of Mines, year 1888. ...

II. PAMPHLETS.

The Thick Coal of South Staffordshire, 1885, ... *Herbert W. Hughes.*
Report of John M. Ronaldson, Esq., H.M. Inspector of Mines for the West of Scotland District (No. 2), 1888. ... ...
Report on the Mauricewood Colliery Disaster, 1890. ...

The PRESIDENT moved the adoption of the Council's report, which was agreed to, and a hearty vote of thanks tendered to the members of Council for the way in which they had conducted the affairs of the Institute during the past year.

FINANCIAL REPORT.

The SECRETARY read the following abstract of the Treasurer's accounts for the past year, duly audited :—

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ABSTRACT of ACCOUNTS for Session 1889-90.

Receipts.

To Balance, 1888-89,							£259	2 9½
,, 177	Members' Subscriptions,	1889-90,	at	21/	each,		185	17 0
,, 1	Do.	do.,		20/6	,,		1	0 6
,, 268	Do.	do.,		10/6	,,		140	14 0
,, 1	Do.	do.,		6/6	,,		0	6 6
,, 7	Do.	do.,	Arrears, at	21/	,,		7	7 0
,, 11	Do.	do.,		10/6	,,		5	15 6
,, 1	Do.	do.,	1890-91, at	21/	,,		1	1 0
,, 5	Do.	do.,		10/6	,,		2	12 6
,, Received for Transactions, &c.,							29	19 4
,, Do.	Rents of Hall,						11	4 6
,, Do.	Advertisements,						7	7 0
,, Donations,							2	11 0
,, Received for Bank Interest,							5	1 8
							£660	0 3½

Payments.

By Printing and Stationery,		£398	13 2
,, Books, Maps, and Bookbinding,		11	8 5
,, Rents of Halls,		15	13 4
,, Gas and Assessments,		2	18 8½
,, Stamps and Carriages,		9	10 3
,, Committee on Coal Cleaning,		27	11 3
,, Sundries,		5	0 0
,, Salaries,		79	12 0
,, Cleaning,		6	0 0
,, Balance in Bank and Treasurer's hands,		103	13 2
		£660	0 3½

7th April, 1890.—Examined, compared with vouchers, and found correct.

J. B. DALZELL, }
ARCHD. KERR, } AUDITORS.

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The PRESIDENT moved the adoption of the Treasurer's report which was agreed to.

ELECTION OF OFFICE-BEARERS.

The PRESIDENT announced that the following gentlemen, who had been nominated at last general meeting as office-bearers for the ensuing year, were now duly elected :—

President :

JOHN M. RONALDSON, 44 Athole Gardens, Glasgow.

Vice-Presidents :

JAMES SMART, Balgreen, Hamilton.
JAMES HASTIE, Greenfield Colliery, Hamilton.
J. B. ATKINSON, 10 Foremount Terrace, Glasgow.
JAMES GILCHRIST, St Helens Colliery, Workington.

Councillors :

THOMAS ARNOTT, Clyde Cottage, Tollcross.
JOHN DRINNAN, Dalzell Colliery, Motherwell.
JOHN GEMMELL, 96 New City Road, Glasgow.
ALEX. M. GRANT, Kilmarnock.
JAMES HAMILTON, 208 St. Vincent Street, Glasgow.
DOUGLAS JACKSON, Ross Colliery, Hamilton.
ROBERT M'LAREN, Crofthill Place, Uddingston.
GEO. A. MITCHELL, 67 West Nile Street, Glasgow.
D. M. MOWAT, Summerlee Iron Works, Coatbridge.
JAMES PRENTICE, Stanrigg Collieries, Airdrie.
MICHAEL ROSS, Dechmont Colliery, Newton.
WALLACE THORNEYCROFT, Merryton Colliery, Hamilton.

The following were elected by ballot as ordinary members :—

ANDREW WATSON, Cadzow Colliery, Hamilton.
HUGH GARDNER, 151 Cathcart Road, Glasgow.
JAMES HENDRIE, Benhar Colliery, Harthill.
ROBERT ARCHIBALD, Blackhall Colliery, Maryhill.
HENRY GERALD, 2 Darnley Street, Pollokshields.
RANDOLPH GORDON ERSKINE WEMYSS, Wemyss Castle, Eas Wemyss.

The PRESIDENT (Mr J. M. Ronaldson) then delivered the following address :—

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PRESIDENT'S ADDRESS.

GENTLEMEN,—On behalf of the office-bearers now elected for another year in the history of the Mining Institute of Scotland, I beg to tender you our warmest thanks for the honour of being entrusted with conducting the affairs of such an important society as the Institute has proved itself to be. As the report of the Council put before you shows, the Institute is in a flourishing condition numerically, and, although the balance on hand is greatly reduced owing to the heavy expenditure necessarily incurred in preparing the Report upon Coal-Cleaning, I venture to say no one grudges this well-spent money. While we congratulate ourselves on continued prosperity, pardon me if I allude again to one point upon which we ought not to congratulate ourselves as a society with 500 members. I refer to the attendance at the ordinary meetings, which is not what it might be. What we require in order to make the Institute more useful still is to have more working bees and fewer drones. Those of our members who neither attend the meetings, nor contribute to the discussions by letter, receive all the benefits, but give nothing in return beyond paying their annual subscriptions. Were the ocean to receive the water of all the rivers which flow into it without giving it back again in another form to the land, we can imagine what the result would be; and it is needless to say what would become of our Institute if all the members became drones. I would therefore earnestly urge those who have the time and the ability—and there are many such—to act the part of the working bee, and contribute so far as possible to the discussions, and thus make the papers even more valuable than they have been hitherto.

While new inventions and new appliances are constantly being introduced for the purpose of saving labour, and thereby lessening the cost of production, it must be remembered that mine owners have to face the fact that year after year mining has to be carried on under increasing difficulties. It requires no demonstration to prove that, when the cream is taken off a dish of milk, that which remains is of less value, bulk for bulk, than that which is removed; and by no process of reasoning can we be made to

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believe that it is anything else than skim milk. Already, in many parts of Scotland, the cream may be said to have been taken off the mineral fields, seeing that the best and cheapest-worked seams are well nigh exhausted, and the problem to be solved by the owners and managers is how to make the skim milk give returns equal to what had formerly been derived from the cream. In these days, when competition is so keen, it will be admitted that a mine owner, with only what I have termed skim milk to work upon, has no slight task before him in holding his own against those who may still be the fortunate possessors of cream. Nothing short of the best of management will succeed under such circumstances, and it is only by careful attention to all details, and a readiness to adopt the very best means suited to meet the various and ever-varying circumstances incidental to mining, that this success can be attained. The value of such reports as were the outcome of the "Propping" and "Coal-Cleaning" Committees cannot be over-estimated, and it should be our aim to have similar reports on other mining subjects. Through the kindness of the mine owners in England, as well as in Scotland, every facility has been given to our representatives, whom we commissioned to make these reports, and, provided funds were available, there is no reason why we should not send many similar committees not only to England, but also to the Continent, and even America. As you are aware, the preparing of many such reports means the expenditure of more money than the ordinary income of the Institute could bear. It would be to the advantage of the mine owners if they, as such, would provide the necessary funds; and if they would do this, the Institute would do its part by undertaking to appoint thoroughly competent members of committee to visit the various districts, and prepare reports upon any subjects that might be decided upon. This suggestion, made some years ago by a former president, I would again put before the mine owners for their consideration.

A year ago I proposed that some one of our members should give a paper dealing with a detailed description of the manner in which the securing of the roof at the working face was dealt with in actual practice, but hitherto there has been no response to the suggestion. Seeing that over 40 per cent. of the deaths from

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accidents are caused by falls, mostly at the working face, I hope that this year the matter may be taken up, and that a thorough discussion of this important subject will follow.

With very few exceptions, in Scotland we sink all our shafts, deep and shallow alike, of an oblong shape, while in England most of the shafts are circular. It is stated that a deep circular shaft, 20 feet in diameter, is about to be sunk in Mid-Lothian, under the directions of gentlemen who have had great experience both in Scotland and England. Doubtless they have good reasons for adopting the circular shape, but a paper dealing with the comparative advantages of the rival shapes of shafts, and the respective merits of wood and wire-rope guides, would prove an interesting addition to our Transactions.

Explosives, in spite of the well-known dangers which attend their use, still hold the field against any mechanical contrivance yet introduced to bring down the coal or surrounding strata, and, owing to the convenience with which they can be applied, and the enormous power developed by them, it will readily be seen that the construction of any mechanical contrivance, as an efficient substitute, is a problem not easily solved. In some of the newer explosives, the danger attending the use of gunpowder from flame appears to have been practically overcome, but, so far as I have been able to ascertain, none of them have proved quite as efficient as ordinary powder for bringing down coal. Further light on any good explosive that emits no flame will be gladly welcomed.

I observe that in many mines there is a growing tendency to make the drawing and travelling roads of larger area than formerly. This is a step in the right direction, and will be found to be real economy. Where the roads are so high that the oncost men and other workmen can travel along them with comfort, and where the hutches do not graze the sides, more useful work per man can be performed than in mines in which the roads are so low and narrow that to traverse them means exhaustive labour, and hutches, once off the rails, can with difficulty be put on again. While the actual cost of making and maintaining the roadways in the one case may be more than in the other, it will generally be found that this apparent gain is more than counter-balanced by the loss consequent upon having roads of contracted area.

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Workmen have to be paid equally the same whether the work performed by them be useful or otherwise. If, therefore, owing to small roadways or any other cause, an extra amount of physical labour is required in order to produce a certain output which, with roomy roads, could be produced with less labour, it is at the expense of the owner, and not of the workmen, that this extra labour has to be performed.

There are many who wonder what will be the ultimate result of the agitation going on at present to get an Act of Parliament passed restricting the employment of underground workmen to eight hours per day from bank to bank. For my part, I cannot see that there is any need for Government interference in the matter. I could understand that, where the physical or moral well-being of any class of workers has suffered from long hours of labour, legislation should be called for; but it remains to be proved that miners, as a class, suffer in this respect. I venture to affirm that, for every miner who can be brought forward as having in recent years suffered physically or morally through long working hours, other fifty could be pointed out as having become physical and moral wrecks through strong drink, and yet we hear of no movement originating among such to remove from their midst that which has been proved to be the greatest curse, not only to miners, but to all classes of the community. On the average, the miner does not at present work more than eight hours per day, and it is quite long enough, but to compel him by Act of Parliament, and for no well-grounded reason, to refrain from ever being more than eight hours per day below ground is a very different matter, and would be as absurd as having an Act passed to compel him to work every day in order that the owners might not be the losers by the pits being idle.

While the thanks of the Institute are due to the writers of the papers from time to time put before us, we ought not to forget those members who prepare the notes on papers in the transactions of kindred societies. The work of making an intelligent—and, at the same time, condensed—summary of such papers is no light one, and you will agree with me that the labours of those gentlemen who so modestly only make themselves known by initials are worthy of our recognition, seeing that we are thus

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kept in touch with other societies, and are informed in a general way of what is causing special interest in other parts of the mining world. I trust that the year of our history just entered upon may prove, with the hearty co-operation of our members, as successful as any of those which have preceded it.

The SECRETARY proposed a hearty vote of thanks to the President for his inaugural address. He had touched on several matters of practical consequence and one or two burning questions which doubtless would be settled one way or other very soon.

The following discussion then took place :—

DISCUSSION OF MR JOHN TODD'S PAPER ON "AN IMPROVED CARRIAGE FOR SELF-ACTING INCLINES.

The SECRETARY called attention to a typographical mix-up at p. 288, par. 3 :—"The carriage is constructed of under the front axle." The reading should have been :—"The carriage is constructed of iron. The trams are of angle iron carried under the front axle and secured to it with steel pedestals. A hole is made in each tram through which the brake shaft passes," and so on.

Mr ROBERT MARTIN said this "improved" carriage is designed to work in a 4ft. seam, with an inclination of 1 in 5, and to get over the difficulty of "handling heavy hutches on plates," and the supposed "apparent danger of working with cut chains." He would say that any form of carriage, except for winding, is quite unnecessary up to an inclination of 1 in 2 or thereby. In

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this particular seam of 4ft. in height, this carriage would require for head room a brushing the whole length of the plane of fully 2ft. This is expensive, and in most seams may be undesirable, and would not be necessary with cut chains. The arrangement is only single acting, whereas cut chains are double acting, and will therefore produce double output. The rope is being worn out carrying a useless balance or "cuddy." The carriage with load on will be very troublesome to get on the rails in the event of its leaving them—much more so than hutches. As to turning of heavy hutches, there is no more difficulty in doing so on the plates of a cut chain arrangement than on plates at pitbottom or pithead. Hutches containing 12 to 13 cwts. of mineral are handled without any difficulty. The "apparent danger" is pure imagination. He could say from some years' extensive use of cut chains working on inclinations of 25° and 30° that not a single accident occurred with them; and there are other places where they have worked as successfully. In the east of Scotland when the inclination exceeds 30° to 35°, a carriage becomes a necessary evil. The arrangement is the same as described. There is a carriage on which any size of hutch can be placed. The ropes are wound over two drums, and the brake on the drum is powerful enough to hold either carriage with load on it or back-balance alone. Talking of danger, he would not like to sit on Mr Todd's carriage on an incline of 60° even though it is provided with a sledge-brake, if the rope or chains gave way. The person in charge, who travels with it, would certainly be in a risky position. A full hutch will skid with wheels locked at an inclination of 1 in 10. The novel or original feature of Mr Todd's carriage is the brake, "a sledge brake which acts upon the rails." It has been found to work very successfully on cable tramways on steep gradients. Mr Todd does not say how it does with himself, and what the outputs are. He would like him to show what brake power he has in a 1 in 5 incline, and to work it out as applicable to what may be called a "steep" gradient, say about 60°, and with wet rails. Putting it roughly, the most that can be got with that form of brake, even though it lift the carriage up off the rails (which may not be a very desirable thing) is the friction of iron on iron, or equal to skidding the wheels of the

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ascending or descending carriage. Those who have worked inclines will have an idea if this will be equal to stopping the carriage short, if running at a good speed, exactly at the various levels. The nearer an inclined plane approaches to the vertical, this brake becomes less powerful where it is most required. With reference to the "jock," this is one of many attempts to get over the difficulty. He remembered seeing a much more effective safety catch on the winding carriages at Newbattle some years ago, but it required a good deal of side room. After all, it may be well to bear in mind what Mr Hyslop states in "Colliery Management," page 228, on a kindred topic :—"Safety cages and disengaging clutches were very much in vogue some years ago, but with equivocal success, owing to their liability to damage from the rough usage to which they were exposed. It seems preferable, therefore, to dispense with the apparatus, and keep up good ropes, tested chains, and strong attachments."

Mr HUGH JOHNSTONE said, judging from the drawing of the carriage, which was not drawn to scale, the cross rails upon the carriage, on which the tub is placed, seemed to him to be very narrow, and he should like to ask Mr Todd by what means he secured the exact placing of the carriage upon the incline so that the tubs may be run out from the branch roads straight on to the carriage. His experience of similar inclines had shown him that if the carriage runs past or stops short of the exact point, there is the greatest possible difficulty in getting the tubs placed upon the carriage. He could quite understand in this case that if the carriage stopped below the exact point, it could easily be brought up ; but if it over-run the stopping-place, he did not see very well by what means Mr Todd could get it brought back to the level at which the tubs could be run on. Further, with regard to the safety of the appliance, it appeared to him from the paper, that the brakesman is supposed to travel up and down the incline with the carriage. This being so, he should like Mr Todd to explain by what means he gets over the difficulty of the man riding on the carriage without a cover.

The PRESIDENT said he noticed that Mr Todd, at page 288 said —"The arrangement is worked with a back balance connected to the carriage by either a wire rope or a chain." He would point

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out that the use of this chain was illegal when this man was riding on the carriage. He would recommend him to stick to his wire rope and not try the chain. Looking at the drawing it seemed to him that the front of this carriage was much too low. It touched the rails. Now, that gave no clearance for anything lying on the incline. Any stone or bit of coal would be apt to catch the front of the bogey. In the absence of Mr Todd he asked if this system had been tried in actual practice. He would imagine, from looking at the drawing, it had not been tried in actual practice. With regard to the "Jock" on the back balance, a similar appliance had been in use for many years on a bogey on a dook in Baljaffray Colliery, and was invented by one of the men. It had not a spring, but the "jock" was sufficiently heavy to fall and catch without a spring.

Mr JOHNSTONE said he noticed the rails shewn were ordinary bridge rails. Consequently he took it that they were not fished at the joints. It might be interesting if Mr Todd pointed out how he got over the difficulty of the sledge brake sliding over the joints. It was well known that such a carriage was easily put off the rails.

Mr FORGIE said they often fished such rails. It was quite a simple matter.

Mr JOHN DRINNAN said that ever since reading the paper he had been in a somewhat hazy condition of mind in regard to the meaning of it. It seemed to him that there were some other members somewhat hazy in regard to what was meant, or he must have entirely misunderstood some things said. One gentleman said the carriage was fitted with a "Jock." Now, at p. 288, it was stated the back balance, not the carriage, was fitted with a "Jock." The President himself was inclined to take exception to Mr Todd's ideas, because a chain was fitted to the carriage. The chain was actually fitted to the back balance, and, according to the drawing, it was wire rope that was fitted to the carriage. He was still in a hazy condition as to how the back balance worked, and whether there was a double road on the incline on which it was worked. One of the things that had troubled him a good deal had been taken up by Mr Johnstone, viz., as to how he would manage to so balance the carriages as

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to make it stop exactly opposite the loading place. If he went too far one way or other, it would be difficult to get it back, and if he allowed it to go at a high rate of speed it would be next to impossible to check it, while if it went at a low rate there could only be a low rate of output. It seemed to him it would require a very careful balancing indeed to have a sufficient weight on the back balance to start it, or otherwise they would require to have a very steep gradient at the top to lift the empty carriage away from the bottom and *vice versa*. It would require such a careful balancing that he was inclined to believe the idea was a somewhat impracticable one. However, he would have liked if Mr Todd had been there, because he might have made things appear in a better light than in the paper,—at least so far as he had been able to see them.

The discussion was adjourned.

The following paper on "The position of the Air Vessel on Large Drainage Pumps and some methods of applying it," was then read by Mr David Landale, jun.

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THE POSITION OF THE AIR VESSEL ON LARGE DRAINAGE PUMPS AND SOME METHODS OF APPLYING IT.

By David Landale, Jun., Engineer, Kirkcaldy.

The application of air-vessels to pumps has of late received a good deal of attention. Some recommend them, while others say they are worse than useless; and even amongst those who do recommend them there is a great difference of opinion as to the size, position, shape, &c. We have some among us who say that they should be of such a size as could not be got into a pit, and the weight of such would be ridiculous.

I have here an entirely new method for your consideration. I am going in the direction pointed by Mr Baird in his paper, viz., to the source of shock, though I go a step nearer it than he does. He went to the pump-barrel for it, while I go to the spear-rods themselves, which I consider to be the direct cause of the shock, and probably most here will be of the same opinion.

We are much indebted to Mr Baird for his paper, as it gives us some data to work from, and also proves that an air-vessel is required for smooth working, and, if working properly, will prevent many a breakage. To work properly there must be a water connection between it and the plunger; if, however, the pump barrel is nearly empty, and the plunger comes into sudden contact with the water, there will be a great shock caused by the inertia of the water and the momentum of the descending plunger. Is this not very often the cause of breakage?

The demand of the pump may be greater than the supply of water, and of course it must then draw air (unless the engine be regulated) which will rise to the top of the barrel; the water will be at the bottom, and the plunger in the down stroke will come against it at a velocity of not less than 2·4 feet per second (taking the pump to be going at six strokes per minute, with a stroke of 12 feet), the plunger and rods weighing perhaps 9 tons or more, giving a blow to the water of 21·6 foot tons, the momentum of the rods, since $M = W\ V$.

Now, if we place the air-vessel in the spear-rods by some

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suitable method, we shall have direct connection between the spear-rods and the air-vessel. I have worked out several methods, and have selected three for your consideration, drawings of which are shewn. The explanation of the construction of the pump will, I think, be readily understood, as all here will be quite familiar with pumps in general.

See Plate I.:—The Pump-Barrel, H.-Piece, Clack-Piece, Valves, and Rising Main, may be of any design capable of working, as their construction does not in the least affect the working of this air-vessel, or necessitate any special construction thereof.

The Plunger *A* on the drawing, and the end of the spear-rods shown at *M*, alone are different from any pump which I have seen or heard of, but as there is nothing new under the sun, it may have been used centuries ago by the celestial Chinaman, or by the Egyptian still further back.

In *Fig. 1*, the Plunger *A* is turned up on the outside in the usual way to fit the gland; inside, however, where the wooden stock is usually fitted and wedged tightly in, it is bored out for a portion of its length. This will be explained further on. At the end of this bored length a ring *D* is cast to prevent the piston *E* going too far into the plunger *A* while charging with air. It also acts as an air-cushion in conjunction with this piston *E*, which, you will see, is of such a shape that it has a large annular space containing air which has to pass through a much smaller opening before the metal surfaces of piston and plunger can come in contact with one another. This ring also prevents the air pressure rising beyond a certain limit; in the case I have taken, the limit is 750 lbs. per square inch.

The bottom of the plunger is made close-ended, and the top has a flange to which the cover *F* is bolted. This has a gland *C* to make a workable air-tight joint round the piston-rod *G*; this is an ordinary gland, though it need not have neck brasses.

The Cover *F* is made to fit closely down on the piston *E* so that it may compress the air as much as possible to force it inside the air-vessel. An air-escape valve *H* should be fitted just below the topmost position of the Piston *E* to prevent the air-pressure rising above that required for working, which I consider should be equal to the working pressure of raising the water; for, if less,

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we would lose a portion of the stroke (the working pressure being always greater than the statical, on account of the friction of the water with the pipes and other causes); and if it were much greater the extra pressure required to lift the valves would cause a slight shock.

To return to the plunger—the air is admitted behind the piston *E* through the valve *J*, and from there it passes to the air-vessel through another air-valve *K* in the piston, both of which are held in position by a slight spring just sufficient to carry up the weight of the valves.

The piston *E* is fitted with ramsbottom, or some such packing-rings, to prevent the passage of the high pressure air round the piston. At the other end of the piston-rod *G* we have a cross-head *L* firmly cottered up to the end of it. This cross-head is a square block of iron or steel, with a hole bored to fit the end of the piston-rod, and a cotter-hole to fix it. Four or more bolts pass through it to attach the spear-rod ends *M M*, which have a projection forged on to catch the under side of the cross-head. Most of the strain on this end of the rods is thrust, so that the snugs on the ends of the spear plates will not be over-strained at any time.

The action of the plunger is very simple. Starting with the plunger full down and the air-vessel uncharged we have first an up-stroke which draws water, not, however, enough to fill the pump-barrel, since the suction-pipes, *H*-piece, and clearance round the plunger are filled with air at atmospheric pressure before the engine starts, and if the suction-pipes have greater area than the displacement of the plunger, the engine may have to go more than one stroke before the air-vessel begins to charge itself. It is necessary that the plunger *A* should have some resistance acting on its surface to press it upwards in order to compress the air contained on the under side of the piston *E*, and to take in air on its upper side through the valve *J* in the cover.

We will suppose the pump-barrel *B* to have been half-filled by the first up-stroke; then, when the plunger meets the water, it will not be stopped at once, but when it has raised the water to a sufficient height in the rising-main to counteract the weight of the plunger, the air will be compressed till the engine has reached

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the bottom of its first down-stroke. The piston *E* has moved down through a portion of the length of the air-vessel, and at the same time has drawn air in behind it. Now, when the engine has come to the bottom of its stroke, we will find the air below the piston *E* compressed, and air drawn into the upper portion of the air-vessel behind the piston.

The engine then starts on its second up stroke, drawing water all the way up this time, let us suppose, so that, when the engine reaches the top of its stroke, we have the barrel full of water. As the resistance in the main is sufficient to balance the weight of the plunger *A*, compression of the air inside the air-vessel will commence at once, and continue till the piston is stopped by the ring *D* inside the plunger, when the plunger *A* will be carried down to the bottom of the engine-stroke. This stroke of the pump will therefore be equal to the full stroke, *minus* the distance the piston *E* moves before meeting the ring *D*. This last motion will go on till the air-vessel is charged. The time of charging will vary according to the ratio of the air-pump contents (*i.e.*, the space which is left behind the piston *E* when it moves down) to the contents of the air-vessel.

The air-pump and air-vessel I have here have a ratio of 5 to 9; and, suppose the working pressure to be 250 lbs. per sq. in., the pressure per sq. in. inside the air-vessel will be raised $\frac{5}{9}$ of 15 lbs. every stroke, taking 15 lbs. as the pressure of the air, giving us an extra 8·42 lbs. pressure at each full stroke, so that in 30 strokes we will have the full working pressure of 250 lbs. per sq. in., and, if the engine goes at the rate of 6 strokes per minute, the total pressure will be got up in five minutes after the air-pump has begun to work its full stroke, assuming no losses, and going upon the theory of Boyle's Law—*i.e.*, the pressure varies inversely as the volume, the temperature remaining constant. $P\,V = \text{constant}$.

We do not, however, require to charge the air-vessel every time the pumps are stopped, unless, of course, there is a large escape of air, which should not be.

Having our air-vessel now fully charged, the pumps commence to do their full work. In the up-stroke, the pump is sucking water, and the plunger is quite rigid. On turning for the down-

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stroke, however, the delivery valve is to be lifted, which requires, let us say, 30 lbs. more pressure per sq. in.—in all, a pressure of 280 lbs. per sq. in. being required to lift the valve with the water above it. This will give us a yield in the air-vessel of $\frac{3}{50}$ of its capacity, as every 1 lb. of pressure above working pressure (250 lbs. per sq. in.) will move the plunger $\frac{1}{500}$ of its capacity, shortening the air-vessel by $\frac{1}{10}$ of an inch for every extra lb. pressure from any cause: giving for the lifting of the valve a movement of 30 lbs. $\times$ $\frac{1}{10}$ of an inch = 3 inches, 30 lbs. being the extra pressure required to lift the valve.

We should, however, consider how much the total movement due to the greatest pressure should be, and, to find it, we may take an extreme shock, which will be caused by the spear-rods breaking. We have also to take into account the weight of the rods. Now, the working pressure of the water in the rising main is the measure of the force applied, and the weight of the rods is usually greater, so that, if the rods were to break or be detached while the pump-barrel was empty, they would fall the whole length of the stroke, which is 12 feet, and their velocity would be accelerated by the force of gravity. Since a body will fall 16 feet in one second, giving a velocity of 32 feet per second, the rods falling through 12 feet, will occupy $\frac{3}{4}$-second in their descent, and have a velocity of 24 feet per second.

Taking W = the weight of the pump-rods, and V = the velocity $= g\,t$, the momentum will be $W\,V$ or $W\,g\,t$.

Now, our working pressure is 250lbs. per square inch, which, with a 14in. pipe, will give nearly 9 tons, and taking this as the minimum weight of the rods which fall through a distance of 12 feet. Then $M = 9 \times 24 = 216$ foot tons, the force which would be applied to the bottom of the pump barrel. The wooden buffer usually fitted is expected to deaden this shock, but, of course, only succeeds to a very small extent.

There is however, no need, I think, to work from this very extreme pressure, as pump rods very seldom break.

The air-vessel which I have here has been worked out from the results of Mr Baird's tests. He finds that in one pump he tried, without an air-vessel, the pressure rose to fully $2\frac{1}{2}$

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times the original working pressure, 270lbs. was the working pressure, and 600lbs. was occasionally registered on the pressure guage.

I have taken a movement of 4ft. as being quite sufficient to take up this shock, which will give, with an extra pressure of 500lbs. per square inch, a movement of $\frac{1}{10}$ of an inch for every 1lb. extra pressure.

The advantages of this system are :—

First.—That we have the room which would be occupied by the ordinary air-vessel.

Second.—Its position is as close to the source of shock as we can place it.

Third.—It cannot become useless by being filled with water, as there is no communication between the water and the air in the air-vessel.

Fourth.—It supplies its own air, being perfectly automatic.

Fifth.—A very large air-vessel may be applied without taking any more room than an ordinary pump without an air-vessel.

The extra pressure required to raise the valves or clacks is given out again whenever they are raised, *i.e.*, the plunger is first compressed with the lift, and then expands immediately after the lifting is completed.

Any, and every extra pressure, however caused, will give a movement in the plunger, the amount of which will be proportionate to the amount of air contained in the air-vessel, and the resistance encountered.

The cost of this system will be somewhat more than for an ordinary set of pumps—about £20 more for a 16in. plunger—and there is an increased number of working parts, which, in the case of a rapid growth of water, would be very difficult to repair in case of an accident.

Breakage, due to shock, is, however, reduced to a minimum. Even in the extreme case of the rods breaking, the full shock would be much reduced, the reduction being proportional to the contents of the air vessel.

I have another method here (Fig. 2) of applying the air vessel to the plunger. It has, as you will see, a piston *E* attached to the bottom of the air vessel fitted to work in the plunger.

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The air is contained on the upper side of the piston this time, and a chain or some such flexible arrangement prevents the piston from dropping out in the up-stroke of the pump, when there is a vacuum on the under side. The piston may be attached to the chain by means of an eye bolt or a snug cast on the piston. The same arrangement would attach it in the plunger to the top of the air vessel. This would have a much more sensitive action than the previous one (Fig. 1), as the piston *E* (Fig. 2) is very much lighter than the weight of the plunger *A* in Fig. 1.

There is also a valve *J* fitted, and connected to the air vessel by a pipe, to admit air but not water, and no relief valve is required.

The method of charging is also much simpler. Some air is admitted along with the water, and collects in the top of the plunger casing. When the plunger descends this air will be compressed, and will go inside the air vessel through the valve *J*; and, as it cannot be pumped into the air vessel at a higher pressure than the working pressure, no relief valve will be required.

Air may escape from the air vessel to the under side of the piston, and thus get among the water. This, however, can only occur in the upstroke, as the pressure of the water in the down-stroke is the same as the air inside. For this reason no water would get inside the air vessel except when there was a shock, and all that could get in then would be easily forced out during the upstroke through the openings by which it came in. The opening of the valve *J* would require air to pass through the packing every stroke of the pump, so that some provision would require to be made to prevent the destruction of the packing of the gland.

The third method (Fig. 3) has a hollow piston rod *G* with a piston *E* cast on the end.

The piston rod, being hollow, forms part of the air vessel, and, if it is desired to be of greater capacity, light iron pipes may be attached above to obtain the desired capacity of air vessel. The spear rod ends *M* have a flange to bolt to the plunger. The gland *C* must be made in halves to be got over the piston *E*, as also must the neck-bush *N*.

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The cover is bored to a sufficient diameter to allow it to pass easily over the piston *E*. The air admission valves *J* and *K* are placed in different positions, though the action is precisely the same. The valve *J* opens to admit air to the pump from the atmosphere, the valve *K* opening to allow the air to pass into the air vessel from the air pump.

The relief valve *H* in this case—and the first—should be placed just immediately below the topmost position of the piston *E*, as it is only to keep the working pressure constant, and not to take away the air when it is compressed by a shock, as it would do in another position.

The air-vessel plunger might be made so that in a short time it could be made quite rigid in case of the air vessel going wrong. The pump would then require to go slower, as there would be no cushion to deaden the shock.

Special adaptations would be required to suit different lifts, speeds of pumps, and other circumstances.

A pump with this cushion could be run much faster than at present without fear of breakage or working rough, and if a small air vessel, just sufficient to take up the shock of the delivery valve closing, were to be placed as near that valve as possible, on the upper side, there could be a still greater speed obtained, thus increasing the working capacity of the pump.

Pumps ought to have two air vessels, one to take up the shocks in the pump barrel, the other to take up the shock of the valve closing, because there are shocks caused on each side of the delivery valve at times when there is no connection between the pump barrel and the rising main, so that an air vessel on the barrel could not take up the shock caused above the valve while it was closing.

The shock caused by 9 tons of water falling through 4ins. (the height a 16in. valve would rise to give full opening), will give a momentum of 3 foot tons, or 36 inch tons. Again, with the air vessel above the delivery valve, the plunger must move all the water below the air vessel before the shock is taken up, and as water is incompressible, it might as well strike against a solid body.

The air in the plunger would act similarly to the buffer of a railway train, though not so easily applied.

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I hope I have succeeded in making my idea clear, and that we will have the opinion of those practically engaged with pumps as to the applicability of this method.

DISCUSSION.

The PRESIDENT said they had had a novelty brought before them. He asked if the pump had been tried.

Mr LANDALE answered in the negative. It was entirely theory.

Mr J. T. FORGIE asked at what pressure the relief valve opened.

Mr LANDALE said it was loaded to the working pressure of the pump to keep the air inside of the air vessel.

Mr FORGIE said that Mr Landale had designed this pump for the purpose of avoiding shocks, and no doubt wherever air could be brought in between the power and the load, the air acted as a cushion, and lessened, if it did not do away altogether, with shocks. But in certain cases this might be done at a sacrifice of the working efficiency of the pump, and that was the opinion he had formed from Mr Landale's description of his pump and the drawings. If the pressure of the air inside of the plunger ram was under the pressure of the column of water, and with the piston *E* it would be difficult to keep it up to that pressure; then, in every stroke of the pump there would be a certain loss of efficiency equal to the difference in space occupied by the air in the plunger ram when the ram was sucking and when it was forcing. This system might be a good way of doing away with shock to the pumps, but in his opinion it was not the best place to put the air vessel. Air vessels should always be placed where they do not lessen, nor have any probability of lessening the efficiency of the pump.

Mr DRINNAN said the idea he had formed was that when the pump started, and until the air was compressed equal to the statical pressure, they would lose some of the stroke, but after that, they had the full stroke.

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Mr FORGIE said he understood that, but what appeared to him the difficulty was to raise the pressure in the plunger ram to, and then keep it at the same pressure as the column, as it was only if the air in the ram was equal to the column that there would be no loss, and it would be a difficult matter to have the piston *E* light enough and workable enough for that. He had noticed in some pumps where the construction was not the best, a great part of the stroke, 6 inches in some cases, was lost owing to air being allowed to collect in places where it should not be. This was what he feared would be the case in this pump.

Mr RONALDSON—The best plan whereby to settle the difficulty is to make a pump and try it.

Mr DRINNAN said the most of colliery managers were so busily employed keeping in order the ideas of their grandfathers they had hardly time to make up their minds in a matter of this kind. But he saw Mr Mowat there, and he thought it might be for the benefit of the Institute if he gave them his opinion with respect to its practicability and what he thought of the figures submitted.

Mr MOWAT said he had no opinion on the subject as yet. He thought there might be a difficulty in keeping *E* from coming out.

Mr LANDALE—There is a strong flexible joint to prevent that.

The discussion was adjourned.

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Fig. 3.

Fig. 2.

Fig. 1.

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CALIFORNIA STATE MINING BUREAU SAN FRANCISCO.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE

ROOMS OF THE CHRISTIAN INSTITUTE, GLASGOW,

29th May, 1890.

JOHN M. RONALDSON, Esq., President, in the Chair.

The minutes of the last General Meeting were read by the Secretary, and confirmed.

The following, who had been duly nominated, were elected by ballot as Ordinary Members.

ROBERT M. MUIR, Hill of Beath Colliery, Crossgates.
ROBERT WATT, Craigend Colliery, Polmont Station.
JAMES GALLOWAY, Trabboch Colliery, Drongan.
JOHN M'GILL, 21 Pitt Street, Glasgow.
GEORGE GALBREATH, 68 Anderston Quay, Glasgow.
JAMES ANDERSON, Hassockrigg Colliery, Whitburn.
ROBERT DUNN, Kennedies, Hamilton.
WALTER WOOD, Broomhouse and Haughhead Collieries, Broomhouse.
JOHN STOKES, Tollcross Colliery, Tollcross.
T. E. STOKER, Crook, Darlington.
A. W. TURNBULL, 27 Charlotte Street, Leith.

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THE LATE MR JOHN DRINNAN.

The PRESIDENT, before nominating a Councillor in room of the late Mr John Drinnan, said he was sure they all deplored the sad accident at Dalzell Colliery by which their friend, as well as another colliery manager, lost his life. Mr Drinnan was at last meeting speaking in his usual way, and now he was absent from them. He thought every one of them, whilst perhaps they did not always agree with his opinions, must have admired the straightforward manner in which he gave his opinion regarding any subject under discussion, and the very fluent manner in which he was able to express himself. He thought he was the first of their Councillors who had been taken away in such a manner, and he thought it was but right on such an occasion that they should make some reference to him. As they all knew, Mr Drinnan was a very indefatigable man in his way, and one thing which they all admired about him was that he spoke exactly what was in his mind. He did not think it necessary to say anything further, but he was sure they all deeply sympathised with Mr Drinnan's widow and family in their sad bereavement. (Applause.)

The Secretary was authorised to minute the Institute's sense of the loss they had sustained by the death of Mr Drinnan, and an expression of sympathy with his widow and family, and forward an excerpt to Mrs Drinnan.

On the motion of the SECRETARY, seconded by Mr THOMAS ARNOTT, Mr Alex. Faulds, Gateside Colliery, Cambuslang, was nominated for election as a member of Council in room of the late Mr Drinnan.

The following discussions then took place :—

MR TODD'S PAPER ON "AN IMPROVED CARRIAGE FOR SELF-ACTING INCLINES."

Owing to the absence of Mr Todd, from whom a letter of apology was read by the Secretary, the discussion of his paper was further adjourned.

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DISCUSSION OF MR LANDALE'S PAPER ON "THE POSITION OF THE AIR-VESSEL ON LARGE DRAINAGE PUMPS."

Mr HENRY AITKEN communicated the following :—On looking at the drawing, the question at once arises : Where should an air-vessel be? Between the ascension column and the clack. Here it is on the other side. How could this give a continuous flow? Next, how could the arrangement pump? One of the plans shews an air-vessel on the ram, or above it more than the cubic contents of the ram. When the ram goes up there would be a partial vacuum at the end of the stroke of say 6 to 7 lbs. per square inch. Then on the return of the ram, it would do so with a bang. I question if even with a tail pipe of only 6 feet one-third of the ram casing could be filled. I can see nothing good in the proposed arrangement; indeed, the opposite. My idea is that an air-vessel should be fed with a small pipe with double clack (double for safety) opening outwards from the top of the ram casing near to the bottom of the air receiver, and so entirely the reverse of what is here proposed.

Mr DUGALD BAIRD communicated the following :—I have read with much interest Mr Landale's paper on air vessels as applied to large ram pumps placed vertically, although I suppose his arrangement would be equally applicable to a horizontal pump, whether single acting or double acting, if suitably placed, only the length required, if horizontal, would be objectionable. The idea of putting an air-vessel on the spear rods instead of on the casing or column, is both ingenious and novel, and no doubt Mr Landale is right in saying that it is to the spear rods that we have to look for the cause of shocks in this style of pump. He places a cushion of compressed air between the ram and the rods. There is no water in connection with this system whatever, and he thus obviates the necessity of overcoming the inertia of the water, which is always a source of shock itself. But when we consider the facility with which air can escape when under pressure, and look at Mr Landale's drawings, I, for one, have grave doubts as to

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the practicability of the systems shown. Take the first case as shown in fig. 1. To prevent the air from escaping, three things need to be in excellent working order.

1. The packing gland, C.
2. The safety valve, H.
3. The inlet valve, J.

Now, while I have no doubt that by careful construction all of these can be made perfectly tight to start with, still it would not be long before they would give trouble. And every day would make them worse. The gland C, with the action of the air-pump and the gritty water falling on it, especially when the movement of it is both irregular as to time and length of stroke, would in the course of two years or so begin to give trouble, and after that time the trouble would increase rapidly. Air at 250lbs. per square inch, or even half that pressure, is difficult to keep a prisoner. The safety valve H requires to blow off occasionally; and what is more likely than that it will get fixed up with a grain of dirt, either from the inside or the outside? I have seen a safety valve of this size on an air-vessel, but it was fixed down where water had to come before air could escape, and although filtered water was inside, still it was seldom that it was not leaking.

Then as to the inlet valve J, seeing that the air goes inside through it, and considering the amount of water and dirt in its vicinity, this valve would be very difficult to keep in order.

Considering the action of the air pump, I cannot see how the pressure of 250lbs., or even 100lbs., per square inch can be raised. As I understand it, the air is compressed into the air-vessel during the up stroke, and there is only the weight of the ram, the suction of the water, and the friction of the packing gland to give rise to this compression, which is something like 60lbs. per square inch. That is, when during the up stroke a pressure of 60lbs. per square inch is attained, the piston will be about 12 inches from the top of the air-pump and make its stroke in that position, Should the engine remain a few minutes with the piston at full stroke down, the air, which will easily find a way past the rings, will become equal in pressure above and below the piston,

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with the result that unless the ram is four feet larger than usual, it will be lifted out of the casing altogether at the top of the up stroke; and as long as it remains full stroke down it will be useless to take up shock.

System No. 2 is simpler, but I find these objections to it:— Should the rings of the piston meet with an accident, or get worn or crusted up, the ram would require to be drawn to repair it. Now, although this looks a simple enough process, still it always turns out a very tedious one, and I will quote an instance which can be authenticated in every way, and which tends to show that drawing the ram is about the last thing most managers would do to cure an evil, because there is not only the ram, but, as a rule, one of these heterogeneous masses of wood and iron, called an apron, exactly on the ram joint. In this case, the ram, owing to being set off the plumb, had got badly worn on the one side, and gave much trouble in keeping the packing, and a new ram was ordered, and came to the colliery with an "urgent" ticket on the waggon, but something like twelve years elapsed before the manager felt justified in taking out the old one, and putting in the new one. I do not give this as a proof of the manager's discretion, but simply to show that drawing a ram is not a simple matter. Referring again to No. 2 system, it is not at all clear to me how the eyebolt A can be fixed into the position shewn, and the same applies to the pipe from A to J. I do not see why the air-chamber should not extend right up to the top of the ram. If that were so the air above A would have a much better chance of being kept inside owing to A being covered with water. As shewn, I believe the first quantity of air and water (for both would go together) that J would pass would leave as much dirt in the valve as make it useless, and even suppose it did continue to act, the water that got in would not get out again, with the result that the air would escape and leave the air-chamber full of water. This is readily realised when we remember that water is 772 times heavier than air, and some engineers tell us that, when compressed up to 250 lbs. per square inch, it will find its way through even two inches of cast iron. The system of charging is certainly not the best, as with this style of pump letting in air with the water is very objectionable. System

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No. 3 is practically the same as No. 1, and has the same defects as to compressing and retaining air. It will, however, commend itself to those who advocate that ten times the ram is the proper capacity for an air-vessel. I am certain that if Mr Landale could get over these practical defects he could lay claim to an air-vessel which far outstrips any other style in sensitiveness and efficiency.

The Secretary read the following communication from Mr ALLAN ANDREWS :—On carefully scrutinizing the drawings, coupled with the assistance derived from the description, I think I understand the action of Mr Landale's apparatus, but I fail to see by what warrant he calls it an air-vessel. It seems to me that the term "air-buffer" would be more appropriate. My idea of the functions of an air-vessel is that it should receive for the moment a portion, more or less, of the water which it is the duty of the pump to discharge, and by that means cause the condition of the water in the column to be gradually changed from a state of rest to a state of motion; and, when the water is once set in motion, although the impulses are intermittent, to maintain that motion as nearly uniform as possible, and thereby mitigate the additional strain to which the parts of the pump are subjected in overcoming the *vis inertiæ* of the heavy body of water in the rising main. I cannot see how the air-vessel designed and explained by Mr Landale contributes to any appreciable extent to the attainment of that desirable end. In order to form some idea as to whether there is any benefit to be gained by adopting Mr Landale's so-called air-vessel, I will endeavour to follow the working of one of his arrangements, and for illustration I will take that shown on Drawing No. 1. In order to save unnecessary verbiage, I will pass over the initiatory strokes of the pump, and suppose the point has been reached when the air chamber has been charged with air up to say 280 lbs. to the square inch, the statical pressure being 250, and I will suppose that the plunger is at the top of the stroke, that the stroke is 10 ft., that the barrel is filled with water, and that the plunger is about to commence the down stroke. I will also suppose that this contrivance, being designed for an air-vessel, the pumps are furnished with no other air-vessel, and that the plunger and rising main are both

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12 in. diameter. If the rising main be less than 12 in. diameter, all the worse for the plunger and all the better for my argument. The weight of a 12 in. column of water of a height due to 250 lbs. pressure is well on to 13 tons. Now, as 13 tons will not start suddenly without a violent effort, the result would follow that the plunger would descend a portion of its stroke, say $\frac{1}{10}$th, before the valve would open under such a load, and the contents of the pump must consequently be delivered during $\frac{9}{10}$ths of the stroke, instead of during the whole stroke, thereby imparting an increased speed to the water in the rising main, and therefore enhancing instead of diminishing the *vis inertiæ*. But although the principle of the air-vessel were ever so beneficial, I am quite of opinion that it would be impossible to maintain a piston and valve, although they were made perfect at first, in such a state of perfection, under such adverse circumstances, as would continue to act as an air-pump pure and simple, and hold air under a pressure of 280 lbs. on the square inch. The result would be, if a pump were made on this principle and put into a pit, that before long it would be working when the valves or piston were out of order, and, as a consequence, no air in the air-vessel, the stroke of the plunger would be shortened by the whole length of the air-vessel, and the pump knocking itself to pieces. As this state of matters could not continue, the end would very soon come, which would be to make the plunger fast to the piston rod, and to set the pump to work as an ordinary plunger pump.

Mr J. S. DIXON said this was a paper which had the merit of novelty. It certainly, on the first blush, was a novel idea of an air-vessel, but the defects had been well pointed out. In the first place, there was a want, as an air-vessel was intended to maintain the continuous flow of the water between the strokes, or as near that as possible; in the second place, there would be great difficulty in keeping the chamber air-tight. That struck any practical man at once. Then, he was afraid that the stuffing-boxes would begin to leak very soon, and the vessel would be inoperative. He agreed with the President that it was an apparatus that should be tried, and its defects would very soon be demonstrated. But it would

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never be an air-vessel in the proper sense of the word from the first objection he had stated. In regard to the remark of Mr Baird about what a serious matter it was to take out a plunger, he could also give a well-authenticated example, where there was a plunger and piston for a pumping engine lying at a colliery for about fifteen years. (Laughter.) They were supposed to be urgently required at that time, and were not in yet. It was a serious matter to stop a pump and allow the water to accumulate in a colliery while such an undertaking was in hand.

Mr DAVID DUNN said, in reading this paper, he had felt, as had been stated by Mr Dixon, the objections to the proposed system of filling or keeping the air-vessel full. These had been pretty well pointed out. He thought, however, in any improvement they might make on the air-vessel, that they should make it tight. He had known several instances of air-vessels where they worked beautifully and had a beneficial effect while the vessel was full, but the longest time he had known them remain so was from thirty to thirty-five hours. In two experiments made with a 30-inch forcing set, by emptying the column of pipes, it was proved on both occasions that the air-vessel emptied in less than thirty-six hours, with the pump working at about forty feet per minute. The first time he had his attention called to the benefits of an air-vessel was in an atmospheric engine. He did not know how old it was. It was much older than himself at any rate. In order to test whether air was in it, he had a small hole bored in it, when no air escaped—water came immediately. Not the slightest sniff of air came. It had worked at that colliery for fully eighty years, and was believed to be air-tight. He had had experience of it since he got older, and they could not over-rate the value of an air-vessel in connection with large force pumps, and it would be very desirable if it could be got always to act as an air-vessel. There must be a great many gentlemen in connection with the Institute who had large force pumps working; and if these pumps were fitted with air-vessels, it would be very interesting to hear if these were tight, and how the supply of air was kept up. He was one of those who believed there was

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not such a thing unless they constantly supplied it with air. He would have no faith whatever in an air-vessel, or substitute for it, as proposed in this paper, from his experience.

Mr THOMAS ARNOTT said he would like to say that there was an automatic way of keeping air-vessels charged up to the statical pressure. It was described in one of the "Transactions" of the North of England Institute, and also, he thought, in Mr Baird's paper.

Mr GEORGE THOMSON, Fauldhouse, said the pumps which he had under his charge were pretty heavy, and they had got air-vessels to the capacity of 320 feet. That was to say, the air-vessel was four feet in diameter, and they had got them 20 feet high. He was not of the same opinion as Mr Dunn as to the air in the air-vessel only remaining for 36 hours. The moment the air-chamber was empty they had only to stop the engine and recharge the air-vessel. It was a known fact that, after they were charged they ran between four and five weeks, and at the end of that period they had to recharge them. The engine worked very badly after the air had escaped, and although he had not had much time for experiments, he had proved that the air lasted in the air-chamber for three weeks by putting a cock at the top of the chamber and allowing the air to escape. With reference to Mr Landale's suggestion as to an air-chamber, his idea seemed to be to have an air-chamber in connection with the spears. Now, what did he say to having it between the discharge valve and the second valve? That was to say, if they had the air-chamber at the casing of the plunger table and had an air-chamber on the ejection pipes as well. He had had one working on that principle, and it had worked very satisfactorily. He did not know whether it was carrying out his idea or not, viz., having two air-chambers. It seemed to him (the speaker) he was inclined to have that. He was afraid his principle of putting it into operation was too complicated. But, as had been said, the best plan was to make one and try it.

Mr DUNN said the last speaker must have a separate apparatus for charging his air-vessel, and during the charging of it he must stop the pump. It would not be convenient at all times and in all circumstances to do that.

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Mr THOMSON said he was sorry to say there was no other method unless running the water off. He was making investigations into the subject of Mr Baird's application with the view to adopting it, but at present they had no other method but that of running the water off and charging the piston.

Mr ROBERT MARTIN said that in connection with Mr Moore's hydraulic pump, which was fitted up at Pentland, he remembered there was an arrangement for feeding the air-vessel when working. They opened the cock and a little air was sniffed in. They worked it for some time. He could not say just now what the results were, but he remembered it was fitted up along with the pump, and the idea was that it sniftered in a little air.

Mr DIXON said he thought the arrangements were referred to in the papers by Mr Baird, Mr Mowat, and Mr Andrews. This snifter cock was a very common way of doing it.

Mr MARTIN said it was described in Mr R. T. Moore's paper.

The PRESIDENT said it appeared to him that theoretically the plans in figures 1 and 3 were not so good as the plan in figure 2, because, supposing the thing could be made to work absolutely tight, he was afraid, owing to the friction caused by the plunger packing, they would not in all cases get the full length of the stroke, and of course if they lost an inch or two of the whole length of the stroke that meant a dead loss. Theoretically figure 2 seemed to be the correct thing, because they had the full length of the plunger stroke. However, to carry the thing out in practice he was afraid it would be rather a difficult matter, for the reasons already so plainly stated in those communications which they had had before them. Instead of putting this so-called air vessel at the end of the spears, could not Mr Landale have a communication from the air-vessel to the top of the plunger, with an intervening piston, such as that shewn in figure 2? It would have the same effect, and there would not be the smallest chance of losing any part of the length of the stroke.

Mr LANDALE then replied. He said, with regard to Mr Aitken's communication, that Mr Aitken did not quite take up the grounds of the thing: he said a part of the stroke would be lost. Now, the suction of the water in charging would be

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quite sufficient to counteract the friction of the gland, and there was no pressure behind the piston E at all, because the valve K opened quite easily with the compression. The pressure was the same on each side of the piston, and should it happen to be greater than the internal pressure when it had gone up it would escape through the valve K. It could not lift the plunger. The weight of the water falling would be quite sufficient to overcome the friction. Mr Andrews said this was not an air-vessel. But an air-vessel was a buffer, and a buffer was an air-vessel in a pump. He considered he was wrong there in saying an air-vessel was not a buffer. This was just an air-vessel put on the plunger. He was quite aware of the difficulty of keeping the parts in working order, but if any one cared to take the trouble of keeping them in order he thought it would be found that with an air-vessel above the clack it would have the desired effect—would break any shock in the barrel, and supply its own air as well; and there was no communication between the water and the air.

The PRESIDENT—That is an advantage.

Mr DUNN—Has Mr Landale a model?

Mr LANDALE answered in the negative. Mr Aitken had said that the pump would go with a bang. That was not the case. Whenever the pump went to the bottom of the stroke it would expand. This air machine could not bang even if it were empty, owing to the formation of the piston E.

The PRESIDENT, in closing the discussion, said they were all indebted to Mr Landale for his paper. He recommended him to get a pump as described and try it, and that would settle the matter. They might theorise for an age, and never get nearer the solution of the matter. Get some coalmaster who believed in his (Mr Landale's) ideas, and get him to give an order, and the pump would be tested. He proposed a hearty vote of thanks to Mr Landale, which was heartily accorded.

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A NEW LONG-DISTANCE ELECTRIC BELL.

By James Kean.

The object of the writer is to bring before the Institute a new form of Electric Bell for signalling purposes; but before doing so it will perhaps be well to take a hasty glance at the mechanism of the ordinary electric bell. This consists of an electro-magnet, and a soft iron armature to which is attached a striker to strike the bell. Fig. 1 shows the whole arrangement.

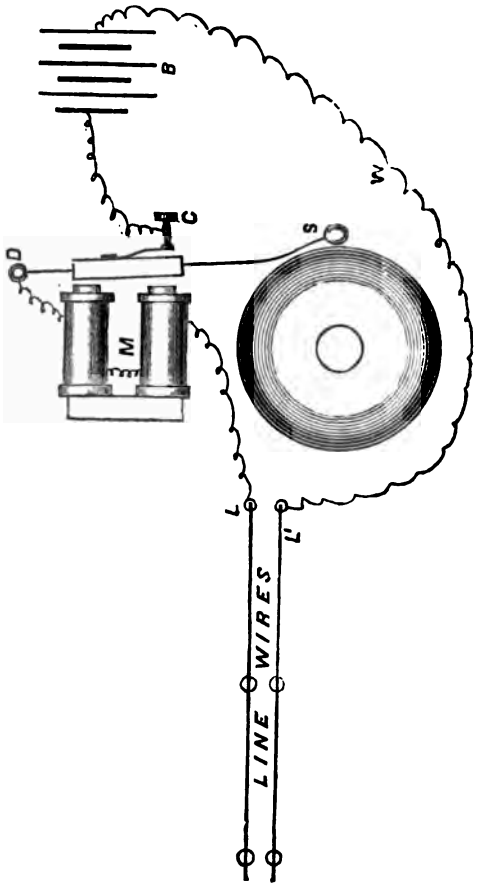

Fig. 1.

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The current coming from the battery B, passes through the contact piece C, along the spring attached to the armature to the stud D, through the electro-magnet M to the line wire L. If we make connection between the line wire L, and return line wire L^1, either by pressing them together or by connecting them across by a bit of metal, the current returns by the wire to the battery, thus completing the circuit and ringing the bell. But supposing the line wires extend to a considerable distance, and a connection be made gradually further from the bell, a point is soon reached where the three cells are insufficient to ring it. Indeed a few yards of ordinary telegraph wire are sufficient to exhaust the power of the cells; the reason is that the iron wire offers resistance to the passage of the current. For this there are two remedies: either the thickness of the wire must be increased so as to reduce the resistance, or a greater number of cells may be employed to force the current through the line wire. The latter plan is always adopted, as it is infinitely the cheaper of the two; but at the best it has some great defects. A large number of cells must be employed if the line is long—10, 12, and 14 cells are often used, and still the signals are not very good. The line wire must be of moderate thickness—not less than No. 11 iron wire. All this means expense; great first cost and correspondingly great cost and waste of time for maintenance. To obviate these defects the system of working by relay was invented. By this system the number of cells used may be reduced by one half. Supposing 12 cells have been at work on the old plan we may now use six only; three for working the relay, and three for working the bell. The arrangement of apparatus is shewn by Fig. 2.

One of the line wires is connected to the relay R; the other line wire is connected to the battery B. When the connection is made, the current passes through the electro-magnet M; the armature is attracted against the stop S; and the current from the local battery A passes through the stop and on to an ordinary electric bell C. The feeble current sent through the line by the three relay cells works the relay easily, though the line may have a great resistance, and the three local cells are sufficient to give a good loud signal. The defects of this system are:—First, the introduction of another piece of apparatus, liable, like the bell

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itself, to get out of order; and the necessity for having one of the line wires well insulated, for unless the insulation is fairly good there will be some leakage of the current from wire to wire,

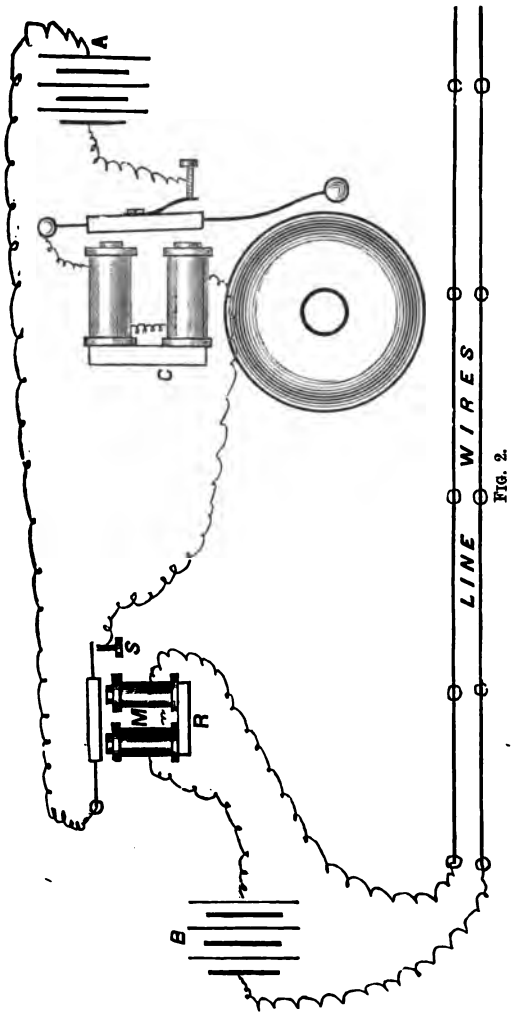

FIG. 2.

and it may, in badly insulated lines, be enough to work the relay and ring the bell continuously. In weighing the advantages and

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the disadvantages of this system, some are inclined to think them so nearly balanced that they go on working by the old plan.

To anyone unacquainted with electrical apparatus, the connections may be a little perplexing, but we cannot help thinking that miners would do well to acquaint themselves with such like problems, as they may be called on to solve more difficult cases in the future.

The new long-distance bell, which is here submitted, is also a relay bell, but so far improved as to leave no doubt as to its advantages. Supposing, as before, we have a line that requires twelve cells, we saw that by the relay system the number could be at once reduced to six. By the new system the number is again halved, three cells only being required. The resistance of the line is practically annulled. All the battery power needed is just what is necessary to ring the bell itself on short circuit. If a good loud signal is wanted, three cells may be needed. For a moderately good ring, two cells. If it is a small bell that can be worked by one cell, then one cell will ring it through the longest line needed in a mine. We have here a small bell (3in.) which will ring well through eight miles of No. 11 telegraph wire with one cell. We will connect it to a circuit of 200 ohms resistance—equal to about eight miles of No. 11 iron wire—and it will be seen that it rings as well through that as it does through a circuit having no resistance. Of course it is too small for mining purposes, and it is only shown to make plain the capabilities of the system. Here is a 5in. bell, suitable for mine work. We will put the relay out of action, and use it first as an ordinary bell. With no resistance in circuit, one cell is not enough, as its moving parts are heavy, but two cells ring it very well. We will now put a little resistance in the path of the current, just to see how much it will stand. One ohm reduces the sound, with two ohms it is very feeble, three ohms stop it altogether. Allowing the relay to come into action, we will add resistance gradually—50 ohms, 100, 150, 200 ohms, and still the signal is very good. In this experiment we see what can be done in spite of the great resistance of the line wire. But the line wire we have used has perfect insulation, a thing very unlikely to be the case with the line wire of a mine. So to suit badly insulated lines it is found

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that a rougher adjustment of the relay is needed. In this case there is placed alongside of the line resistance an artificial leak. Our line is made 50 ohms resistance, and the coil of wire which represents the leak allows one-third of the total current to pass through the relay. This exactly represents what takes place on a badly insulated line. If we attempt to work through more than 50 ohms, the relay refuses to move; and if we adjust it to work with more than 50 ohms line resistance, then the leakage will be strong enough to work it, and false signals will be given. For this defect there is no remedy, the insulation of the line must be looked to. It is, indeed, a defect of the line, and the chattering of the bell proclaims that the energy of the battery is continually being wasted whether the line is at work or not.

Fig. 3 gives a general view of the bell and relay with their connections, the gong being removed to show the relay. The relay is of somewhat special make, having been designed with a view to simplicity of construction combined with certainty of action. It consists of an iron frame F, to which is attached a single pole electro-magnet. In front of the magnet pole there is bored a hole in which a short iron plunger works loosely, and which is attached to a metal spring S. When a feeble current passes through the electro-magnet, the iron plunger is attracted towards it, until the spring is brought into contact with the platinum-pointed screw C. This action completes the local circuit, and the bell rings. If we follow the path of the current from the battery, along the line, through the relay and back to the battery, we will see better how the one battery can work the relay and ring the bell at the same time. At present, as the Fig. shows it, there is no possible path through which the battery current can flow. If we follow either of the two wires from the negative pole we soon arrive at a break in the circuit which prevents the current from passing. Taking the wire leading to the bell, we follow it to the contact screw, along the armature, through the electro magnet to the spring S of the relay; here it is stopped by the air space between the spring and the contact screw C. It cannot pass unless the spring be pressed against the screw. If this be done, it passes along the upper wire to the battery, and the bell rings. Taking the lower wire from the negative pole, we can follow it to the relay through its electro-

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magnet and along the line of telegraph wire, but it cannot pass any further unless we make a connection from the one wire to the other. If this is done the current will return by the other

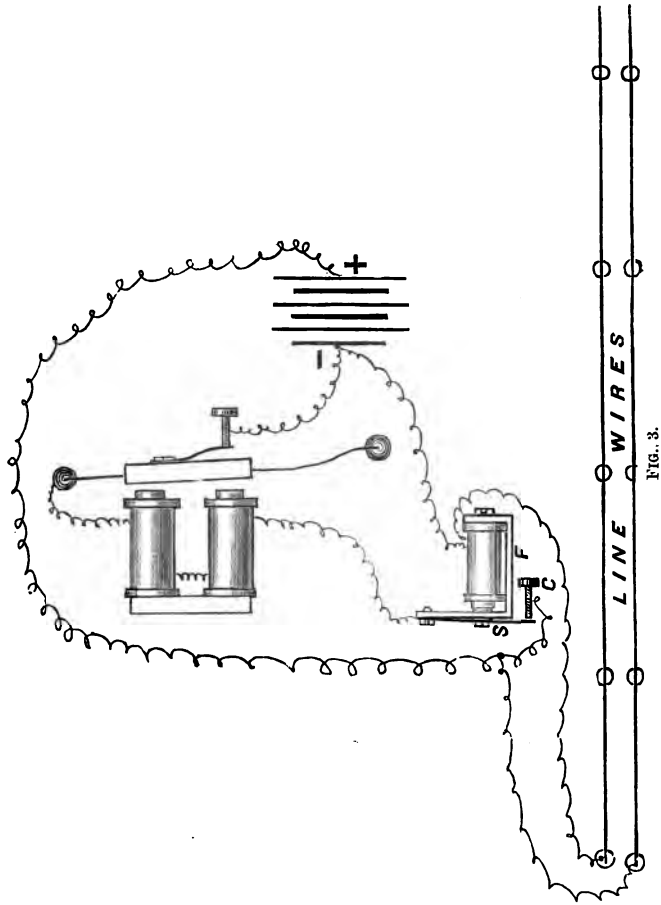

FIG. 3.

line wire, and passing along the upper wire in the Fig., reach the positive pole of the battery. The circuit is thus completed, and the electro-magnet of the relay attracts the little soft iron plunger, making contact at the screw C. The current has now two closed

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paths presented to it. It may choose either, or it may go along both. What it actually does is to divide itself between the two circuits in proportion to the amount of opposition they offer.

The bell circuit being made up of a short length of thick wire, offers little resistance, while that of the relay being made up of a long length of thin wire, offers great resistance. The current passing by the relay, is so small that it makes no difference practically on the ringing of the bell. The work it has to do is so small that sufficient current may be taken from the battery without making any noticeable difference in the ringing current. It also gets some help from the fact that the bell current is an intermittent one, as, at every break caused by the bell vibrator, the relay gets the full strength of the battery all to itself.

DISCUSSION.

Mr DIXON asked if this small battery could be applied to existing bells, because most collieries were fitted with bells, which rang more or less perfectly, though if they could be perfected, by the addition of this relay, he thought it would be very desirable.

Mr KEAN replied in the affirmative. He at the same time stated that they preferred to send out the bells complete with the relay on instead of making up old bells, as sometimes there was a little difference in the resistance, which put the bell circuit and the relay circuit out of proportion.

Mr GEO. A. MITCHELL said Mr Kean had explained very clearly the difference between the three different systems. As far as he (the speaker) understood, the reason he could do with fewer cells with the relay than without it was that he made them do double duty. That was to say, in the old system without the relay the same cells worked the circuit and worked the bell, whereas with the relay (old style) there were separate cells for the bell and for the wires. But was it not the case that, although fewer cells were used, those used would run done quicker?

Mr KEAN said the current that was taken up by the relay was

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so small that it would make no practical difference. In the old system, they had two batteries—one to ring, and one to work the relay.

Mr MITCHELL—Is not the same total current required in the new as in the old system?

Mr KEAN—The double current will be the same in the old and new, only there will be fewer cells in the latter.

Mr MITCHELL—Will they not run done the quicker in consequence? If so, it does not seem to be any great advantage to have fewer cells if those in use require re-charging oftener.

Mr KEAN—No, not perceptibly quicker. It could hardly be measured—it is so small. The solution and chemicals only required to be taken into account, the current is so small the cells ought to last a long time.

Mr MITCHELL—Of course, electricity is mysterious, but one would imagine that, if the cells were doing double work, they would require to be charged the oftener.

Mr KEAN—I don't think that the new system would make one penny of difference in a year.

Mr DAVID ROBERTSON said—Suppose they put as fine wire on the large coil as on the relay, what would the effect be?

Mr KEAN—The effect would be the bell would not ring unless you put on more cells. The relay wire would be too fine. It would offer too much resistance to the current.

Mr ROBERTSON—Would finer wire not be better for greater distance?

Mr KEAN replied that to put on a fine wire would then be an advantage. The wire should be proportioned to the resistance of the circuit to get the best effect with the fewest number of cells.

Mr ROBERTSON said at a colliery from week to week and month to month the distance was ever increasing, and he asked what the effect on the batteries in these circumstances would be.

Mr KEAN—If you rewind the magnets with a finer wire, it would be an advantage.

Mr ROBT. WADDELL said the resistance was very much in the magnets. In the old relay they had two separate magnets, each of which required cells—viz., three to work the bells and three the

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relay. But in this new system they increased the composition so much that the relay did not take much from the cells, so that the cells were left to do the duty of ringing the bell. Was that so?

Mr KEAN said it was so, so far as, in the old system, they could not do without two batteries, whereas in the new one they could do with one. The difference in the waste was so little it could hardly be measured.

Mr MITCHELL—Could you not couple up the old relay system the same as the new?

Mr KEAN—Yes; we could do that quite well. Of course, that is the point of the invention how to do that. It has never been done before.

Mr MITCHELL—The difference is you have a better relay?

Mr KEAN—Yes.

Mr MITCHELL—And a different method of connecting the wires?

Mr KEAN—Yes. The connection of the wires is the principal part of the invention.

Mr MITCHELL asked if, under the old system without relay, it was not the case that, with the same number of cells as in the relay system, the bell would ring, although faintly.

Mr KEAN—You would require to put on a lot of cells to make it ring.

Mr MITCHELL—You show six cells in the one, and twelve in the other. Supposing you have all the six on the old without the relay, would you not get a faint ringing of the bell?

Mr KEAN—You might possibly get the same ringing or no ringing at all.

Mr MITCHELL—Would the same current that would work the relay not ring the bell?

Mr KEAN—No.

Mr ROBERTSON asked, if the bell was made up with as fine wire as the relay, would the bell not serve the same purpose alone?

Mr KEAN—No; it would not make it any better.

Mr ROBERTSON asked if it was not possible to have the coils of such fine wire that they could sound the bell half a mile or one mile.

Mr KEAN said that would not get over the difficulty. Suppos-

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ing they started at half a mile, it would not ring at a mile without putting in more cells. If they made the wire fine, they would not require to put on so many cells. There was a saving in cells at first. The longer the line, the finer the wire should be on the electric magnet.

Mr DUNN said those apparatus for ringing a bell in all cases coming under his observation did so with a continuous ring. Could it not be so arranged that it would give the necessary number of signals instead of a continuous ring?

Mr KEAN said they could make a single stroke bell as well as a vibrating one; but, all things considered, he thought a vibrating bell gave the best signal.

The discussion was adjourned.

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CALIFORNIA STATE
Mining Bureau
SAN FRANCISCO.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON,

10th July, 1890.

JAS. S. DIXON, Esq., ex-President, in the Chair.

The minutes of the last General Meeting were read by the Secretary, and confirmed.

Mr Alexander Faulds, Gateside Colliery, Cambuslang, was elected a Councillor in room of Mr John Drinnan, deceased.

The following, who had been duly nominated, were elected by ballot as Ordinary Members.

WM. F. RUSSELL, 175 West George Street, Glasgow.
HENRY STEVENSON, Portland Collieries, Alfreton, Derbyshire.
ROBERT ALLISON, Frew's Land, Burnbank Road, Hamilton.
MARK BRAND, Faulds Park, Baillieston.
The Hon. W. H. RUTHVEN, Barncluith, Hamilton.
ROBERT MILLER, Priestfield Terrace, High Blantyre.
GEORGE ROBERTSON, Springfield, High Blantyre.
RICHARD JAMES HALL, Union Gold Mining Co., Moodie's, Transvaal.
WALTER ROWAN, Dundee Natal Coal Co., Natal.
JOHN M'DONALD, Jr., Greenhill Colliery, Holytown.

The following discussions then took place :—

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DISCUSSION OF MR TODD'S PAPER ON "AN IMPROVED CARRIAGE FOR SELF-ACTING INCLINES."

The SECRETARY read the following communication from Mr Todd :—In reply to the discussion, I have to say that Mr Martin is certainly in error when he states that 2 feet of extra brushing would be required in a 4 feet seam to allow the carriage to be worked. The top of the hutch (when on the carriage) is 3 feet 10 inches above the rail, and the height of the hutch itself is 3 feet, so that only 10 inches of extra height is required.

As to the working on an incline of 60°, it was never proposed nor intended to be worked at any such inclination. The steepest at which the brake will successfully operate is 1 in 3½.

I may say, in reply to Mr Johnstone, that the drawings are to a scale of 1 inch = 1 foot.

The placing of the carriage opposite each road is a simple matter, and one which is being daily practised, and therefore it is unnecessary for me to say anything about that.

Coming to the President's remarks, there is no part of the carriage nearer to the ground than three inches.

Mr GEO. THOMSON said he was afraid that the inclination at which Mr Todd proposed to work this carriage was too flat. One in five was not an incline where one who had been accustomed to work with carriages on highly inclined places would adopt it. He had worked inclines with self-acting carriages at an angle of 69°, also as low as 39°, but, as a rule, when the inclination got reduced below this point it was desirable to adopt the cut-chain which could be worked satisfactorily, even with heavy hutches. Some of the members were not clear as to how the hutches were got on the carriage, or how the carriage could be stopped at the exact place. Mr Todd did not require a railway guard to travel with his carriage. Each of his levels should have a distinct signal to the brakesman, and the practical working of a carriage was done in this manner: they might have on an incline ten or twelve levels. No. 8, say, was ready, and it was his ben, for they must understand that each level was regulated by bens, which the oversman or man in charge looked after. Now, all was ready; No 8 signal was up; the brakesman, on coming to

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this level, had the indicator to show the right point, and he generally pulled up just before coming to the room mouth; and No. 8 had a small block of wood which he fixed on the road, so that the brakesman could not pass the proper place. He pulled off the empty hutches and put on loaded ones, then down with his signal, and away went the carriage to the bottom of the incline, which could be done in 30 seconds on a hundred yards incline. Mr Todd should dispense with his latch on the end of the rails for keeping the hutch on the carriage, and introduce two upright standards, with a movable piece of iron at each end to fix the hutch at the ends half-way up on the wood. This would keep the hutch much steadier than the latch on the rail. The carriage should be got up on as light a principle as possible with wood, to save weight for back balance. He might be working his sledge brake satisfactorily at the low angle he had got, which would be about 10°, but he (the speaker) was afraid it would be useless at a greater angle. He did not approve of his snap chain arrangement. He would be much safer with a short attachment to his carriage—say hose, one link and muzzle.

Mr ROBERT M'LAREN said he was struck with the proposal to run the carriage on an incline one in five. The system of cut chains, so well known in Fife and to Mr Thomson, was well adapted for such an inclination as was proposed. Indeed, those of their number who did not believe in them should go to Fife to see them working. They worked with them on inclinations much greater than one in five, and would never think of anything else. In reference to the back balance, the question had been asked: Suppose the carriage went beyond the bench, how would it be brought back? That occurred every day. Sometimes the brakesman forgot and let the carriage too far below the level at which he intended stopping, and in that case proceeded to the next level where the signal had been given indicating that the carriage was wanted. On the whole, as to the carriage spoken of in the incline, he did not think that any practical man would think of putting it on where the inclination was such as was spoken of.

The CHAIRMAN closed the discussion, and moved a vote of thanks to Mr Todd for bringing the subject before them.

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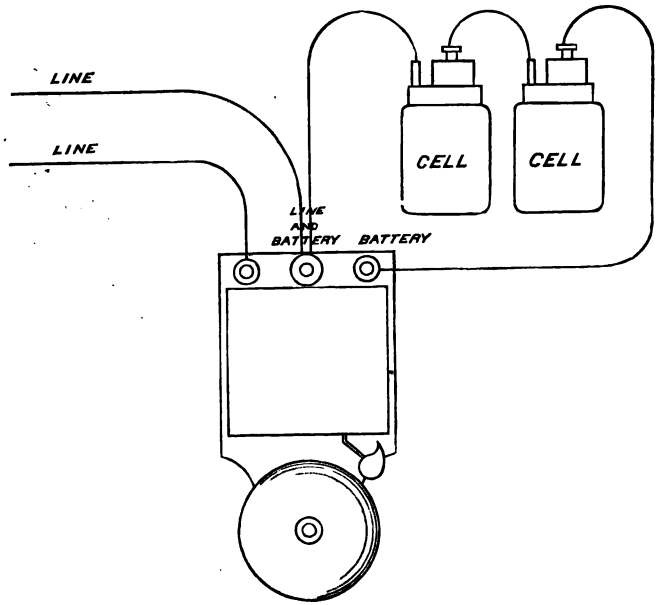
DISCUSSION OF MR KEAN'S PAPER ON "A NEW LONG-DISTANCE ELECTRIC BELL."

The CHAIRMAN, in introducing the discussion, said he held in his hand the prospectus of the Cox-Walker Swinton Patent Magneto-Electric Signal Bells, and, from what he had read of it, it seemed to be a very simple apparatus, for, to quote the prospectus, it "generates electric currents from the mechanical force required to move a coil of wire in the vicinity of a permanent magnet without any need for a battery at all." If that was really the fact, it seemed to him this was the most advanced thing in the way of electric bells.

Mr ANDREW NISBET said he had had one of Mr Kean's bells in operation for nearly a year, and it had given him no trouble. He had only charged the battery once.

Mr GEORGE THOMSON said he had been accustomed to the old



arrangement of the bells, and they gave them a great deal of trouble. They had fitted up one of Mr Kean's bells, and found

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that it was much more easily managed and worked satisfactorily. What he was going to draw their attention to was the diagram in the Transactions. It would have been more to their benefit as members of the Institute if Mr Kean had given them the simple arrangement which he had sent him (shewn in the foregoing figure).

Mr THOMAS ARNOTT said it was very plainly set forth on the bells themselves where the wire was to be connected. The reason why the new bell worked so efficiently was that it was not affected to the same degree as the old bells by any loss on the line wires. He had had one working at 600 fathoms since the beginning of the year with three cells, and it had given very little trouble. He would not recommend any one to get their present bells altered to these. They would not do so well.

The discussion was then adjourned.

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The following paper on "Propping at Straiton and Pentland," was then read by Mr Robert Martin :—

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PROPPING AT STRAITON AND PENTLAND.

By Robert Martin.

In the President's address to the Institute at last annual meeting he suggested that some one of our members should give a paper dealing with a detailed description of the manner in which the securing of the roof at the working face was dealt with in actual practice. The remarks here submitted are a response to this, and it is hoped they will open the way for a full and comprehensive consideration of all the methods of propping and spragging which prevail in the various districts of Scotland. The fact that over 40 per cent. of the deaths from accidents in mines are traceable to falls from the roof and sides gives this subject an importance second to none. The question has been frequently before the Institute, and it is perhaps quite proper that later members should be told that Vol. I. contains an able discussion on the comparative merits of longwall, stoop-and-room, and stooping, so far as safety from falls is concerned. The question of propping is discussed at great length in Vol. II., and this led to the appointment of the Committee on Propping, whose valuable report and discussion thereon is to be found in Vol. III. The reference to Scotch practice in this report is very slight, and detailed accounts of the methods in use at our mines and collieries are still wanted. The writer ventures now to lay before the Institute a chapter from actual experience. The Committee on Propping in their report (Vol. III., page 51) remark:—"The system of propping is so inseparably connected with the mode of working that we have described at some length the various modes adopted." It will be necessary, then, that both should be described as we proceed.

The mode of working at Straiton and Pentland now to be described was stoop-and-room, the general arrangement of which is shown on plan (Fig. 1), in a seam fully 6 feet thick, lying for the most part at an angle of about 30 degrees; but small portions were as flat as 13 degrees, and as steep as 69 degrees. The minerals were won from mines running from the surface in the seam, with levels, which were numbered, branching off at from 30 to 60 fathoms apart. The greatest

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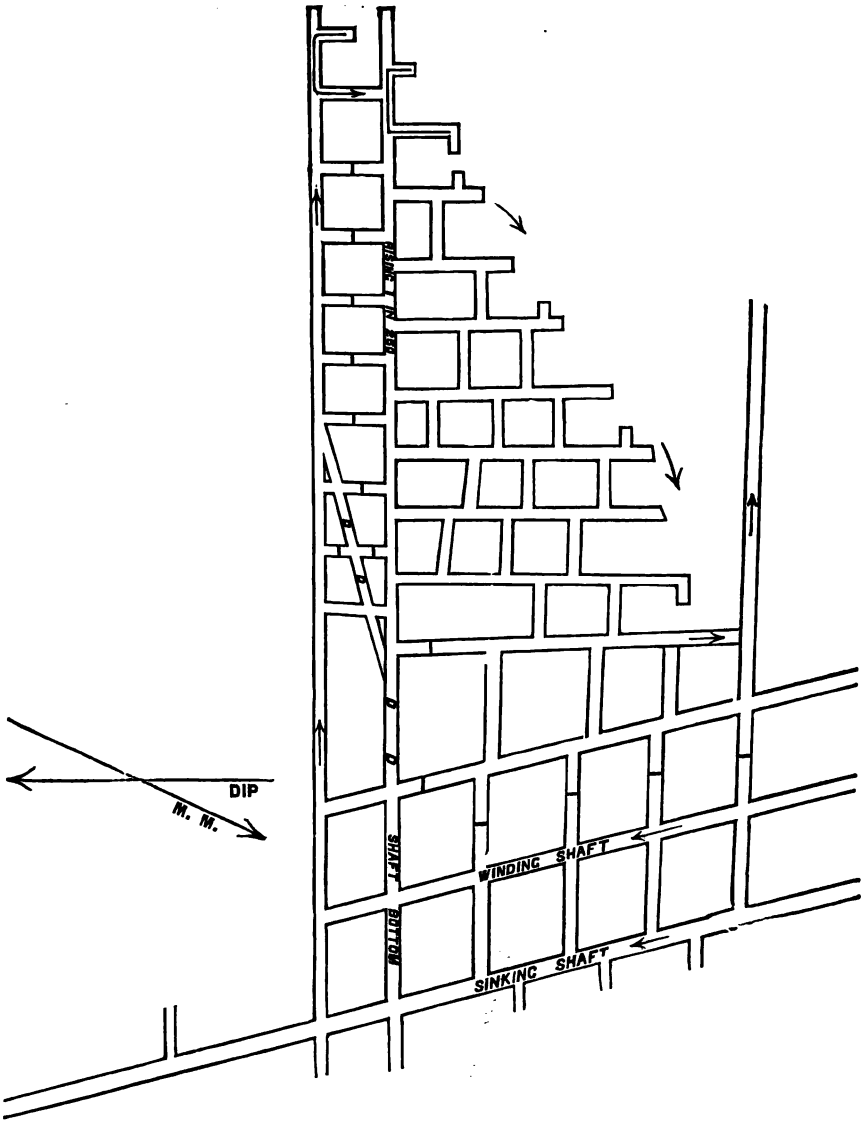

FIG. 1.

Not drawn to Scale.

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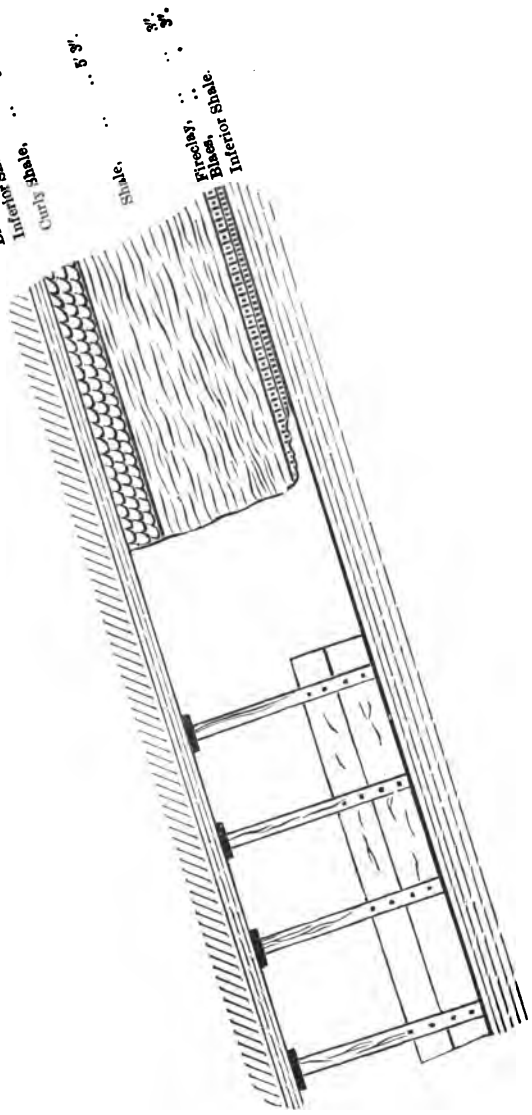

FIG. 2.

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depth on the plane was about 400 fathoms. Pillars were made larger to the dip. At 60 fathoms vertical they were left 26 feet × 40 feet; at the greatest depth—170 fathoms—the size was 36 feet × 60 feet. The openings were 12 feet wide. The roof, seam, and pavement were as shown on Fig. 2. Both roof and pavement were soft. The inferior shale above the seam lay in long thin beds, with very sharp edges, and partings as smooth as glass. This shale acted as a sort of shell or skin, and, if kept from breaking there were no falls. Above this for a considerable distance were beds of caulmy blaes, with hard stone bands, from 2 to 3 inches thick, and thin streaks of fireclay. The seam was strong shale, fully 6 feet thick, which required to be blasted. The props, 4 inches diameter, were set at right angles to the roof and pavement, in double rows in the upset, 4 feet

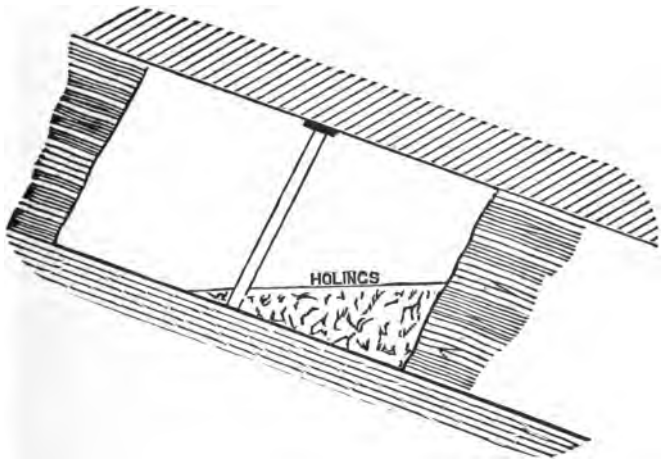

FIG. 3.

apart up the hill and from 2 feet 9 inches to 4 feet across, as shown on Figs. 2 and 4. In the lower or deeper levels the distance was reduced to 3 feet up the hill. The distance allowed from the

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face to the nearest props was only what the miner required to work in. It was found that 9 feet was sufficient. The lids were 15 inches × 4 inches × 2 inches. The "throughers" or ends were driven halfway from each side, and the shale thrown out by the miner into the shoot. A single row of props was set in the ends, as shown on Fig. 3. In the deeper levels, where, owing to greater top pressure, the roof got tender, a strap or crown, 4 feet 6 inches × 9 inches × 4 inches, was put on every second row of props. Owing to the nature of the seam no spragging

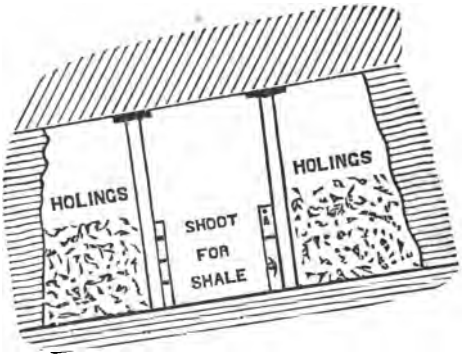

FIG. 4.

was required. The propping of the roof gave facilities for the stowing of the holings of blaes and fireclay made by the miner. These had to be kept in the pit. Two or three planks, 9 inches × 3 inches, were nailed one above the other on the props (as shown, Figs. 2 and 4), so as to form three divisions in the place. The centre one served to pass the shale down to a spout at the foot, flat shoots being laid with steel sheets, and the side spaces held the holings. The props, lids, crowns, and planks were supplied to the miner at the nearest horse lye, and taken by him or his drawer to the face, and it was his duty to make and keep his shoot and secure his working place according to the method adopted. The system was

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enforced in this way : A book was kept for this and other purposes, with a sufficient number of columns, with headings as under—

No.....Level. Description of Places as Found on.....18 .

No. of Place.	Miner's Name.	Width of Place.	Props Apart, 4′ Average Width.	Width of Shoot, 2′9″ to 4′.	Brattice Cloth from Face (Feet).	Remarks.

A person went round twice or thrice a week and filled in the figures as he found them. If the report showed anything wrong or not properly done, the most effective way to get it put right was to stop the drawer from getting tubs till the place was reported on as correct. The report was also a check on the fireman for ventilation.

The extra cost of working this system—*i.e.*, in addition to the ordinary colliery officials—was ·2 pence per ton; but other benefits were got for this charge in addition to systematic propping. The cost for props was ·8 pence per ton, and for planks and other timber, 1·26 pence per ton.

For a period of five years (1883-87) the accidents from falls from roof and sides were :—Fatal—roadsman, 1; non-fatal—miners, 9; drawers, 1; roadsmen, 3. Most of the accidents were caused by roof or shale slipping on the steep ground after it fell. The average number of men and boys employed during the same period was 527, and the total output about 1,000,000 tons.

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DISCUSSION.

Mr ARNOTT asked if it was intended that the stoops spoken of were to be extracted.

Mr MARTIN—No, not at the time.

Mr ARNOTT—Do you think they will ever be got?

Mr MARTIN—I am not very sure about that.

Mr M'LAREN said Mr Martin had not mentioned the propping in the stooping.

Mr MARTIN—There was very little stooping.

Mr M'LAREN—If you could have added that it would have been very valuable.

Mr MARTIN said he had had so little stooping, and only along the outcrop, that he could not do that.

Mr JAMES SMART asked if stoops 60 by 36 were not very small for 170 fathoms of cover.

Mr MARTIN said when sinking the shaft in the solid there was a movement on the roof—it was so tender.

Mr SMART—If you have a very tender roof 36 feet is a very small pillar.

Mr MARTIN—Where the roof moved, there was an opening 9 feet wide, and no pillars.

Mr HASTIE—Did many of the props break, seeing the stoops were so small?

Mr MARTIN—No, they merely sunk into the pavement. The stoops were formed double the size—they could scarcely be got round with ventilation—but the increased size made very little difference.

The discussion was adjourned.

The following paper on "Working Thick Coal Seam by Longwall at Balgonie Colliery, Fife," was then read by Mr Robert M'Laren :—

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WORKING THICK COAL SEAM BY LONGWALL AT BALGONIE COLLIERY, FIFE.

By Robert M'Laren.

In bringing this paper before the members of this Institute, I am aware that there are several systems of working thick coal seams, apart from the ordinary system of stoop and room; and it is very desirable, and would prove helpful to many members, if, while discussing this paper, those members who know of the various systems would come forward and contribute to the discussion.

Balgonie colliery is situated in the parish of Markinch, county of Fife, and is owned by Mr Charles B. Balfour. The certificated manager is Mr Alexander Jamieson.

The seam worked is the Dysart Main coal, which lies in the upper coal measures.

The field is 300 acres in extent, of which about 40 acres are worked.

Two shafts are sunk, 600 yards distant from each other. The Julian pit is 80 fathoms deep, and the Lochtyside pit 61 fathoms deep.

Pumping machinery is fitted at both shafts, the growth of water being 700 gallons per minute.

The output of coal is about 500 tons daily.

The section of the seam is as follows:—

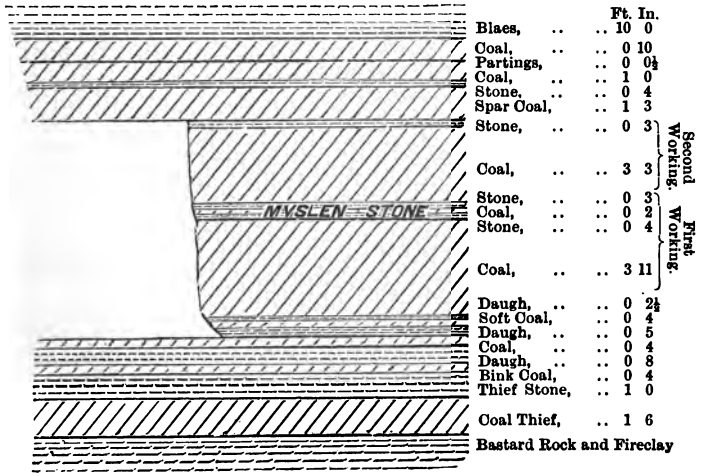
MYSLEN STONE
Ft. In.
Blaes, ... 10 0
Coal, ... 0 10
Partings, .. 0 0½
Coal, ... 1 0
Stone, ... 0 4
Spar Coal, .. 1 3
Stone, ... 0 3
Coal, ... 3 3
Second Working.
Stone, ... 0 3
Coal, ... 0 2
Stone, ... 0 4
Coal, ... 3 11
First Working.
Daugh, ... 0 2½
Soft Coal, .. 0 4
Daugh, ... 0 5
Coal, ... 0 4
Daugh, ... 0 8
Bink Coal, .. 0 4
Thief Stone, .. 1 0
Coal Thief, .. 1 6
Bastard Rock and Fireclay

Fig. 1.—Scale. ½ inch = 1 foot.

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The inclination is irregular, varying from flat to 1 in 2½. The strata give off black damp very largely.

The system of working about to be described was begun by Mr Jamieson four years ago, and, as the system developed, several small difficulties in matters of detail presented themselves, which were not thought of at the start. These difficulties were, however, gradually overcome, and the system is now working well.

In describing the method, it is necessary to state that the workings had to be put away in sections—the section consisting of the area between two parallel headings. (See Fig. 6, sections 1 and 2.)

A section is commenced by driving a heading in the bottom coal, or first working, to the rise, and from this heading ordinary working places are branched level-course, 12 yards apart. The ordinary working roads are 10 feet wide, and, in order to give height, the colliers brush down the top coal to the stone immediately below the spar coal. Roadside buildings are put in, 2ft. 6in. long, across the faces. The buildings consist of the Myslen stone, frequently mixed with slabs or "gauting" wood, in lengths of 2ft. 6ins. The remaining portions of the wall are packed by the debris and dross from the coal, so that no open cundies are left. The holing is in the daugh and soft coal; but in some cases the daugh next the Bink coal is holed in, in order to make debris to pack the walls. When the weight on the face is not too keen, heavy holing is the rule. "Rances" are used in the workings to a large extent. These are props about 5ft. long.

The following plan and section show an ordinary working place in first working. The section also shows the "rance" up to the coal:—

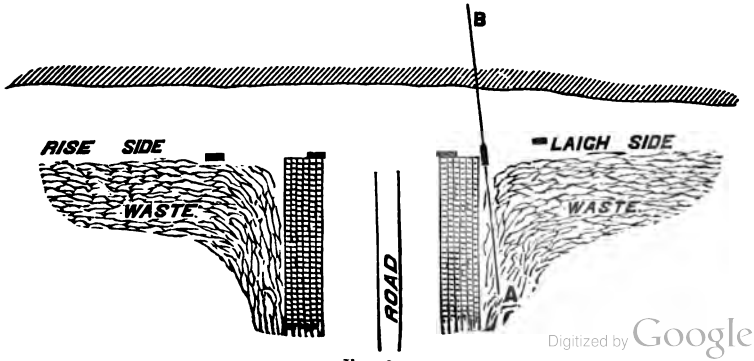

FIG. 2.

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While the workings in No. 1 section are going on, another heading is being pushed forward for the next section, and, as the ordinary

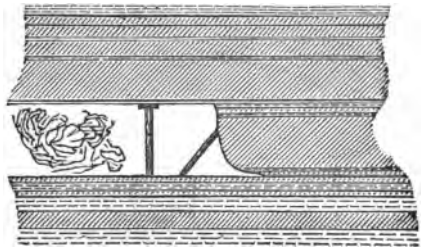

FIG. 3.
Section on line A B. Scale, $\frac{1}{8}$ inch=2 feet.

places in No. 1 section come on this heading, they are stopped in the first working, and preparations are made to begin the second working when convenient.

As soon as the heading in No. 2 section has cut off all the places in No. 1 section, the second working is begun. Between the heading of No. 2 section and the places of No. 1 section, a barrier or stoop of coal, 15 yards thick, is left to protect the former heading in the first working. This barrier is got out when the second working of No. 2 section is in operation.

In the second working, the inside place is begun first, and driven about five yards back before the next place is begun, and so with the others; each place, therefore, being five yards in advance of its neighbour. The coal worked is taken to the lyes by the roads made in the first working, and, as the places move outwards, the rails are lifted to be used again at some other part of the pit. To build and pack the places, the stone immediately below the Spar coal, with the debris and dross, are used, and care is taken to leave no open spaces; but if any spaces must be left for want of material to pack, they are usually left in the old roads. In many cases, the workmen allow the Spar coal to fall behind them, and when this does occur, it is filled and sent to the pithead.

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The following are a plan and section of the working face in the second working :—

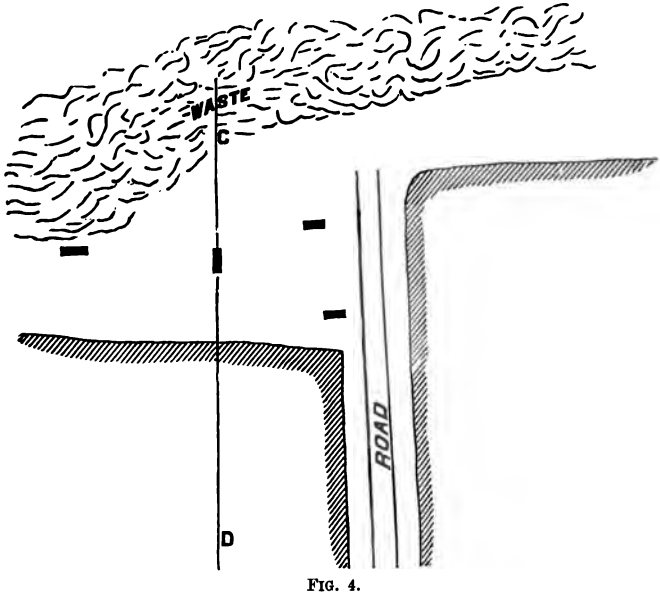

FIG. 4.

Owing to side pressure the roads are about 6ft. wide instead of 10ft., as originally made.

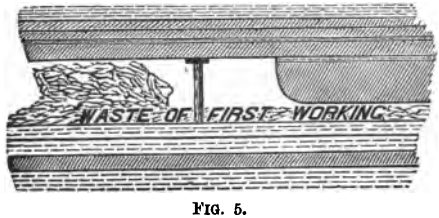

FIG. 5.
Section on line C D. Scale $\frac{1}{8}$ in. = 2 feet.

By pressure from above and heaving of the pavement, the bottom of the coal in the second working and the pavement of the first working are almost together.

The ventilation in the first working is very good. To ventilate the second working the current used for the section in the first working is split, and part diverted round the faces. At times it

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is difficult to keep the whole current from traversing the faces of

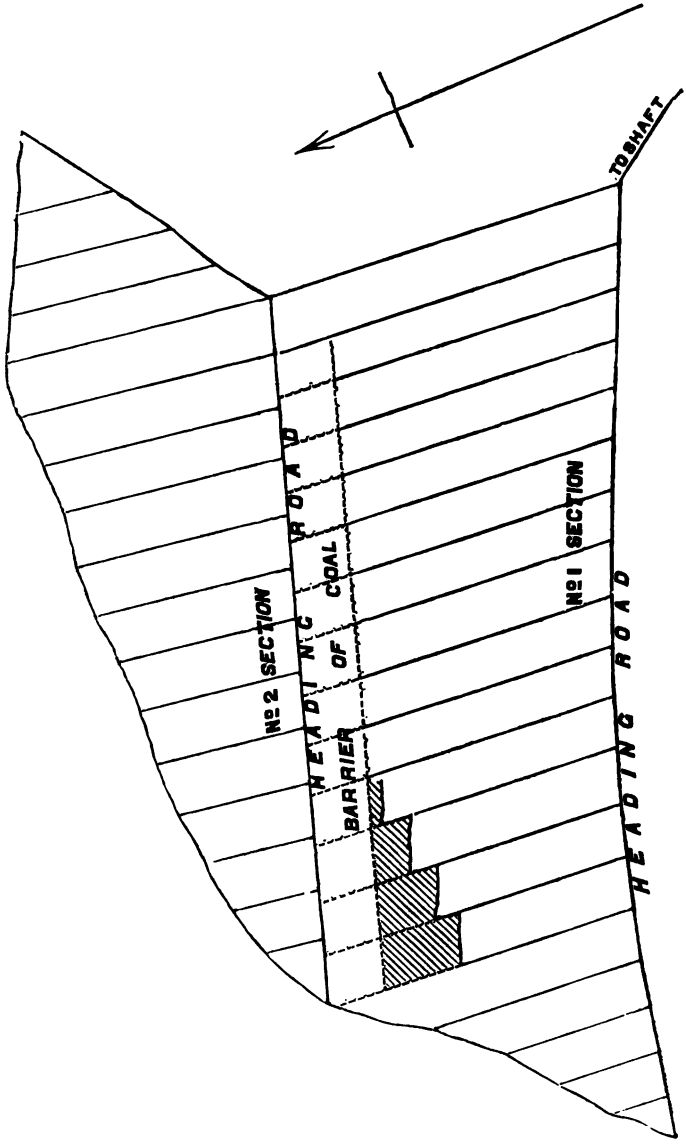

FIG. 6.

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the second working; but when this occurs means are taken to send the air to the required section of the first working, and a scale only is allowed for the second working, which is usually sufficient.

The coal in both workings is taken by drawers to the horse lyes, whence it is conveyed by horses to the shaft.

The advantages claimed for this method of working in thick seams are :—(1) That the whole available coal is got; (2) That the working faces are much easier ventilated than in stoop and room; and (3) That, as to safety, efficiency, and economy, it will compare favourably with any of the present methods of working thick seams.

Gob fires are of frequent occurrence in this seam by spontaneous combustion, but up to the present there has been no fire in this working due to this cause. I may remark in connection with this matter that it has been found in practice a good preventive of fire to keep the area of sections as small as possible, in order to get all the coal out quickly; and when a section is finished, the old roads are sealed up to keep air from getting into the gob. It has also been found, in connection with these fires, that they sometimes begin near a rib side, and, in order to prevent this, long buildings are put in next the coal. It is for the same reason that the waste is well packed, as fires readily take place where the waste is not well stowed.

In conclusion, let me say that some of the coal seams in the Lanarkshire district, lying close to each other, or only separated by a few feet or inches, have been almost lost for want of a proper method of working, notably the Pyotshaw and Main coal seams, where, if one seam was got all right, it was very often at the sacrifice of the other. Might not some such system as that described be attempted for those seams, in order to get both worked, and make the country richer thereby? It is in the hope that, where two seams lie close together, or where, as in this case, there are ribs of stone in the seam sufficient to build or pack the walls, some method be adopted to get the largest quantity of available coal possible, that I have brought this paper before your notice.

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DISCUSSION.

The CHAIRMAN characterised the paper as a valuable contribution to the Transactions. He also remarked that the system described was not exclusively confined to this colliery. It was extensively adopted in Fifeshire and also in other parts of the country.

Mr M'LAREN—Not in Fifeshire.

The CHAIRMAN—It has been worked at Leven Colliery.

Mr M'LAREN—Yes; but instead of coming back with the second working they go forward.

The CHAIRMAN said at Dalmellington they worked the thick seam in three sections very successfully by this system for many years. He had no doubt others would have had examples of it.

Mr M'LAREN said the Dysart Main seam was worked in other two ways; in one case stoop-and-room; in the other longwall, although going forward. In both cases they have had gob fires.

The CHAIRMAN said with reference to the gob fires that in nearly every instance they took place close to a rib side of the coal or at the boundary of the stooping and travelled from that into the waste and workings. It was a very good suggestion to fill up the space alongside the solid coal. He had known a great many instances of fires close to where the strata hang over from the solid coal.

Mr ALEX. FAULDS said fires had taken place in the Virtuewell coal at Motherwell, close to the rib side owing to its tarry nature, and at Dalmellington, where the strata hang over the head coal and in the waste.

The discussion was adjourned.

CALIFORNIA STATE MINING BUREAU. SAN FRANCISCO.

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THE MINING INSTITUTE OF SCOTLAND.

ANNUAL EXCURSION

AND

SUMMER MEETING, AUGUST, 1890.

THE proceedings included an Excursion to London, extending from 19th to 23rd August, and a General Meeting there.

Upwards of fifty members took part in the excursion, the main contingent leaving Glasgow Central Station on the evening of 19th August. There was no official programme of excursions in London and neighbourhood, and the party, making Cannon Street Hotel their headquarters, arranged themselves into sections, and did the sights of the Metropolis as it suited their various tastes. Not the least attractive of the excursions thus carried out was a visit to Woolwich Arsenal. Thursday, the 21st, was set apart for visiting the International Exhibition of Mining and Metallurgy in the Crystal Palace. British Mining was inadequately represented in the Exhibition, but a good opportunity was afforded of viewing the valuable products of some of our Colonies, notably New South Wales. Through the kindness of Mr Eustace Smith, jr., one of the members of the Institute, the party was entertained to dinner in one of the rooms attached to the Exhibition.

There was held a

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GENERAL MEETING

IN

CANNON STREET HOTEL, LONDON,

22nd August, 1890.

Mr JAMES GILCHRIST, Vice-President, in the Chair.

In the absence of the Secretary, the minutes of the former General Meeting were read by the Treasurer and confirmed.

The following were elected by ballot as Ordinary Members :—

JOHN ROSS, Garrockhill Colliery, Drongan, Ayr.
MATTHEW P. DICK, Glasgow.
ROBERT SEGGIE, Inkermann Works, Paisley.
JOHN HAMILTON, 10 Brown Street, Hamilton.
HUGH MEIKLE, Ayr Collieries, Annbank.

The discussion of Mr Kean's, Mr Martin's, and Mr M'Laren's papers was then adjourned.

It had been arranged to return on Saturday morning, the 23rd, but the attractions of London proved so great that the party delayed their departure till the evening. The proceedings throughout were much enjoyed by those who took part in them.

The following papers were afterwards received :—

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MELDRUM'S FORCED COMBUSTION FURNACE FOR BURNING SMALL COAL UNDER STEAM BOILERS, &c.

By Mr F. J. ROWAN.

UNDER the general name of "forced combustion" appliances have been introduced for obtaining a more rapid combustion of the coal upon an ordinary steam boiler fire-grate, and for imitating to a certain extent the conditions and action of a gas-producer in each boiler furnace.

It is to the latter class that the apparatus devised by the Messrs Meldrum, of Manchester, belongs, and, consequently, this apparatus has been successfully introduced for profitably using breeze from gas works, coal dust, and other descriptions of fuel of poor quality in such a state of division as to render them for the most part useless with ordinary methods of combustion. In view of the rapidly-extending use of systems of coal cleaning and washing, such an apparatus possesses considerable interest and value for colliery owners and mining engineers, as it offers them a means of utilizing their coal dust and other refuse fuel for raising the steam which is required for the work of the colliery.

Briefly described, this apparatus consists of a fire grate with special fire-bars, and a closed ashpit into which an efficient form of steam jet blower is introduced.

The illustrations show the arrangement in various forms, Fig. 1 being a sectional elevation through the centre of one furnace; Fig. 2, a front elevation of the whole arrangement as applied to a Cornish boiler; Fig. 3, a similar view of a Lancashire boiler; Fig. 4, a similar view of an ordinary marine boiler; and Figs. 5 and 6, front elevations of the arrangement applied to boilers of either the egg-ended or the water-tube class. Fig. 7 shows a vertical boiler fitted with this apparatus.

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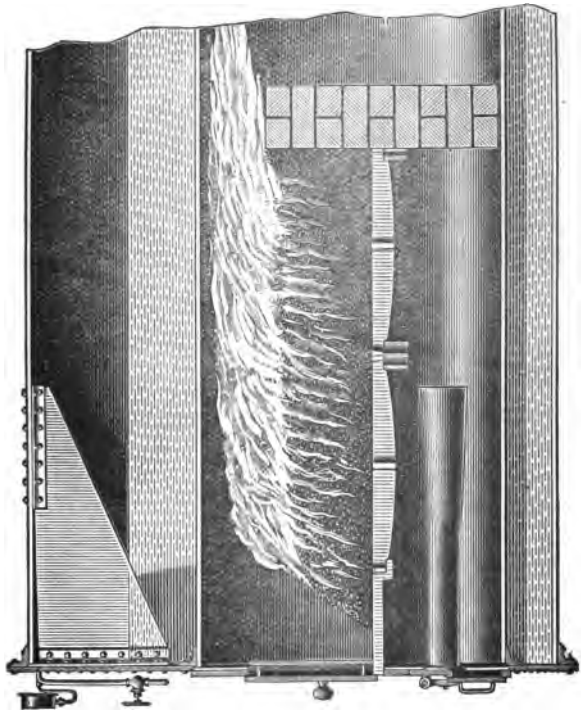

FIG. 1.

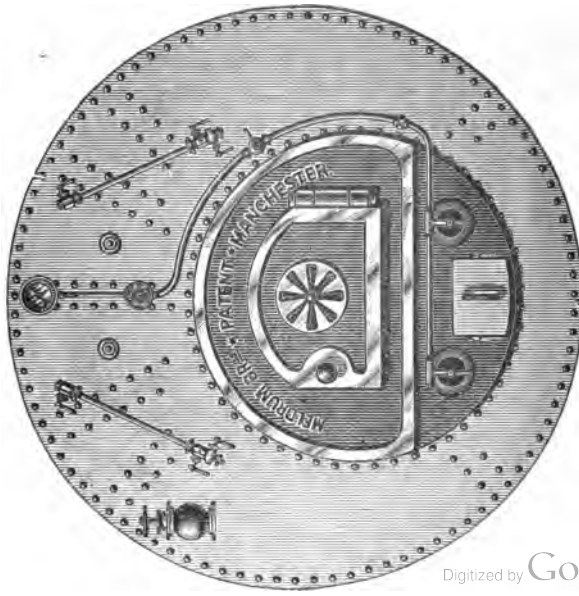

FIG. 2.

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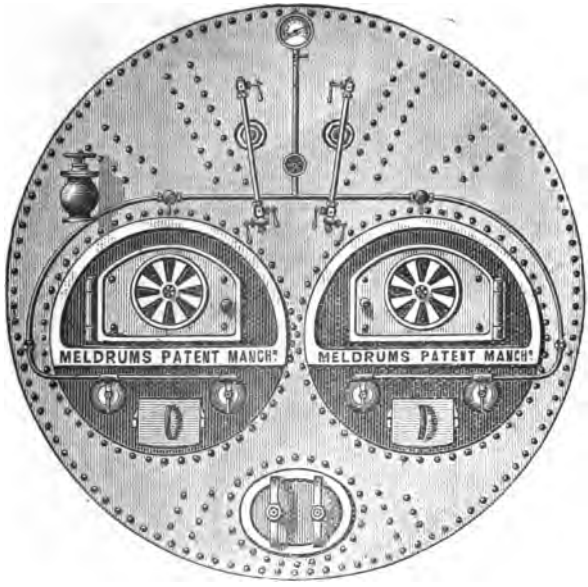

FIG. 3.

FIG. 4.

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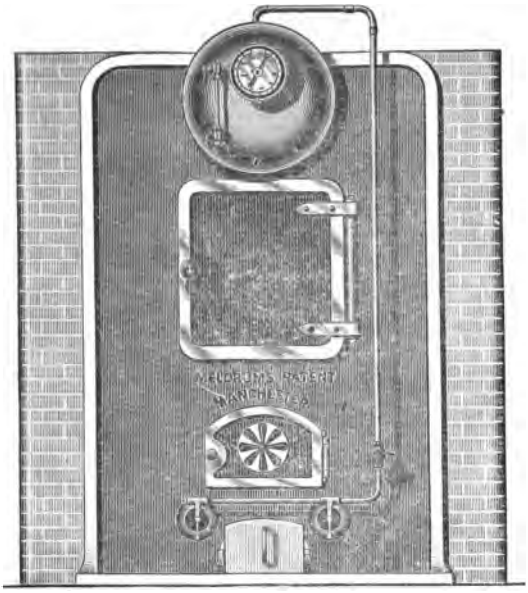

FIG. 5.

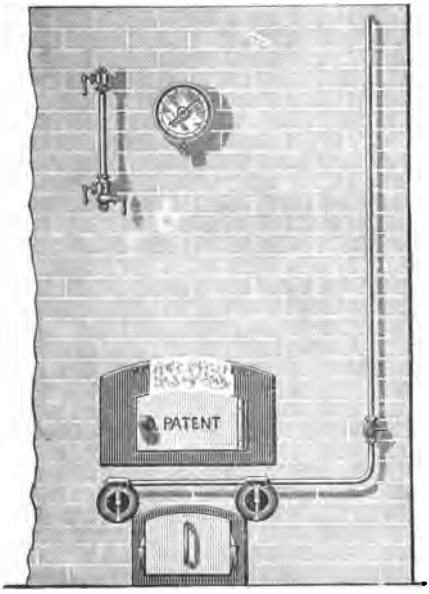

FIG. 6.

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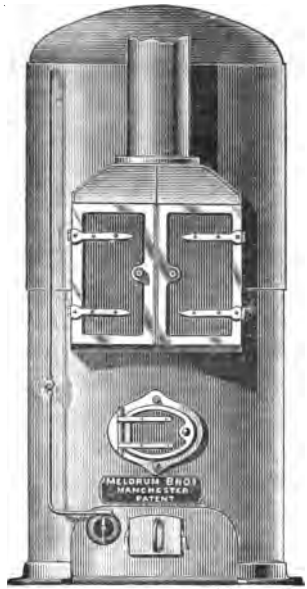

FIG. 7.

It will be seen from the illustrations that the ash-pit is closed by means of a close-fitting iron plate, in which there are two circular openings and a door for removing the ashes. To each of these openings is fitted a trumpet-shaped tube, into which steam is admitted from the boiler by proper connections. When steam is turned on a powerful current of air is created, and by this means the fires are either forced or slackened by the simple opening or closing of the valve by the fireman. Only sufficient steam is used to preserve the bars, and the small proportion used both prevents the clinker from sticking and keeps the bars cool. By an ingenious arrangement of the ash-pit door perfectly air tight joints are secured, and this does away with the use of screws, whilst the size and form of the steam nozzles and blower tubes have been the outcome of considerable experience and experiment.

The fire-bars are of a special form, and are so designed that nothing of value can fall through, whilst the removal of ashes

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does not require attention oftener than once daily. These items of saving have been found sufficient to cover the cost of steam required for working the blowers.

Fuel of extremely low class has been used successfully with this apparatus. In one case steam has been raised for days continuously by firing with waste rubbish which contains about 30 per cent. moisture and 40 per cent. incombustible matter, but the remaining 30 per cent. does very good work, evaporating at the rate of 10 lbs. of water per 1 lb. combustible. With ordinary breeze or coke-dust, containing 20 per cent. moisture and 15 per cent. incombustible material, each pound of breeze will evaporate $6\frac{1}{2}$ lbs. of water. Trials have been made with coal-dust from settling ponds, and good results have been obtained.

Over one hundred boilers have been fitted with this combustion arrangement since its introduction about a year ago, and nearly fifty others are in process of being fitted. The first examples north of Carlisle are two Cornish boilers which have recently been fitted for Mr Monk, the general manager of the Partick, Hillhead, and Maryhill Gas Coy., Limited, at their Temple Farm Gas Works at Maryhill. Mr Monk is kind enough to allow me to state that he will be glad to show these boilers at work with this system of firing at any time.

Besides the great saving possible by the use of very inferior fuel this system has other economies, such as its smokelessness and its not requiring any skilled labour. The draught or rapidity of firing can be regulated at will by the jets, and the whole arrangement is easily applied, as it is self-contained, and requires no extra space, nor power for moving parts.

Although with very small fuel its proper function is that of a gas producer, yet with better class fuel it may be used simply for obtaining a much greater rate of evaporation from a given boiler and grate surface. When it is desired to force the boiler the rate of combustion may be as high as 40 lbs. per square foot of grate, and the rate of evaporation may be raised to 10 lbs. per square foot of heating surface.

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ON AN IMPROVED PATENT METALLIC PACKING FOR PISTON RODS AND PUMP PLUNGERS.

By ALEX. M. GRANT.

Every one who has to do with engines and pumps is aware of the great amount of attention that needs to be paid to the packing of engine piston rods, pump rods and plungers. The amount of trouble and anxiety that the ordinary types of fibrous packings frequently give, the great expense that is involved in continually renewing wasted packing, and in extra enginemen's time and wages, to say nothing about occasional serious and inconvenient stoppages of work to re-pack the stuffing-box, point to the need of an improved system.

With the view to overcoming these difficulties, no engine or pump detail has received more attention than this, and a perfect packing has been long sought after.

Improvements on previous packings have been introduced from time to time, and the writer of this short paper has devoted considerable attention to this subject, and has recently patented some improvements in metallic packings, which have been practically tested, and so far every trial has been an unqualified success.

Previous patents in connection with packings for piston rods and plungers have been, as a rule, for pure fibrous packings, either of a special material or of a special manufacture of a commonly-known material, or of a combination of fibrous and metallic materials, or of a purely metallic packing.

It is not intended in this short paper to describe or remark on any other packing, either fibrous or metallic, but to describe the metallic packing introduced under the writer's patent as a substitute for the fibrous and other packings which come under the observation of steam users.

The packing under notice could be used—and it was at one time intended to be used—in combination with asbestos or other fibrous substance such as are used for steam, water, or air packings. But the practical trials have, so far as they have gone, been very successful with it as a pure metallic packing, and as such it is proposed to be introduced, and to it, as such, the following description will be confined.

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In Fig. 1, A is the ordinary stuffing or packing box; B, the packing gland, and C, the piston rod or plunger. The gland and

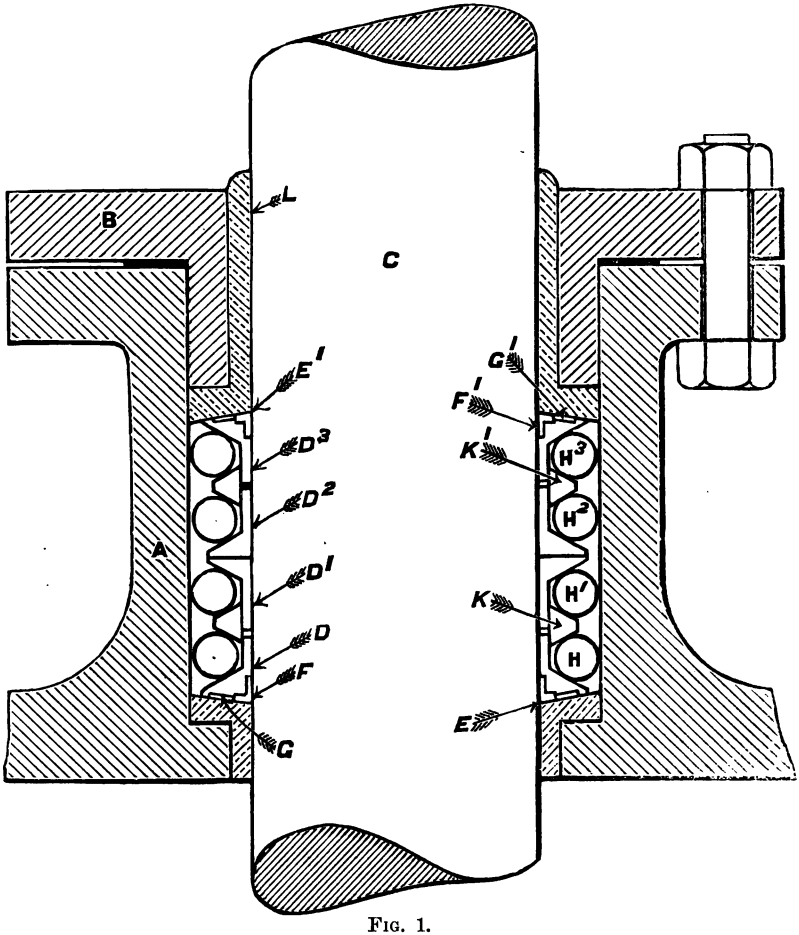

FIG. 1.

box are shown with the brass bush and neck ring as in ordinary practice. The top and bottom rings D D^3 of the patent improved metallic packing are made at E and E^1 to fit the curve, angle, or flat surface on the bottom of the packing box and gland, and each is cut so as to grasp the piston rod or plunger, C, firmly. The inner packing rings, D^1, D^2, are also formed of one piece and

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cut, as in the former case, to grasp the rod or plunger. The distance rings K K^1 of the form shewn are slipped over the outside of the packing rings, and thus form the internal cone for the endless coil springs, H, H^1, H^2, H^3, which exert a pressure on the rod or plunger, and at the same time as they advance on the cone, owing to tension on the springs, cause a pressure laterally, forcing the rings apart on to the faces at E, E^1, thus forming a steam, air, or water-tight joint at these points. The packing gland, B, is screwed hard down upon the flange of the packing box, and a soft joint is formed at L. The packing rings are all fitted with a special packing or tongue piece at the point where they are cut, and D, D^1 are fitted with special rings, F, F^1, which are accurately ground into each other, and between the two rings the grooves or recesses, G, G^1, are formed to receive any jointing material, such as asbestos, wick, &c., which may be required when the packing is being fitted into an old packing-box.

In applying the packing to existing engines, the engine is disconnected at the cross-head, and the latter drawn back sufficiently far to get off the packing gland. The gland is then taken off and the old fibrous packing torn out. The stuffing or packing box is then carefully cleaned out. The metallic packing rings, F, D, are now sprung over and pushed along the piston rod, but not into the packing-box; the endless coil spring, H, is then forced by hand on the back of F packing ring, D; the distance ring, K, is passed to its place next to the spring, H, on the back of D; the packing ring, D^1, and coil spring, H^1, are pushed on to the rod; the packing ring, D^2, and coil spring, H^2, are pushed into their place; the distance ring, K^1, coil spring, H^3, and packing rings, D^3 and F^1 are placed into their position on the piston rod or plunger, and the whole packing is then forced hard into its place in the packing-box. The joint ring, L, is then passed over the packing gland, and the gland, B, is brought hard down on to the packing rings at E^1, forming a tight joint, and is at the same time bolted hard upon the soft joint, L. The engine is now connected at the cross-head, and the packing is completed and the engine or pump is ready for work. The packing shewn on the sketch is for a 6in. rod, and for smaller sizes a smaller number of packing rings and springs are to be used.

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From the foregoing description it will be seen that the packing is of a very simple kind, and can easily be applied by any intelligent engineman to existing packing-boxes, or by pump men or sinkers to

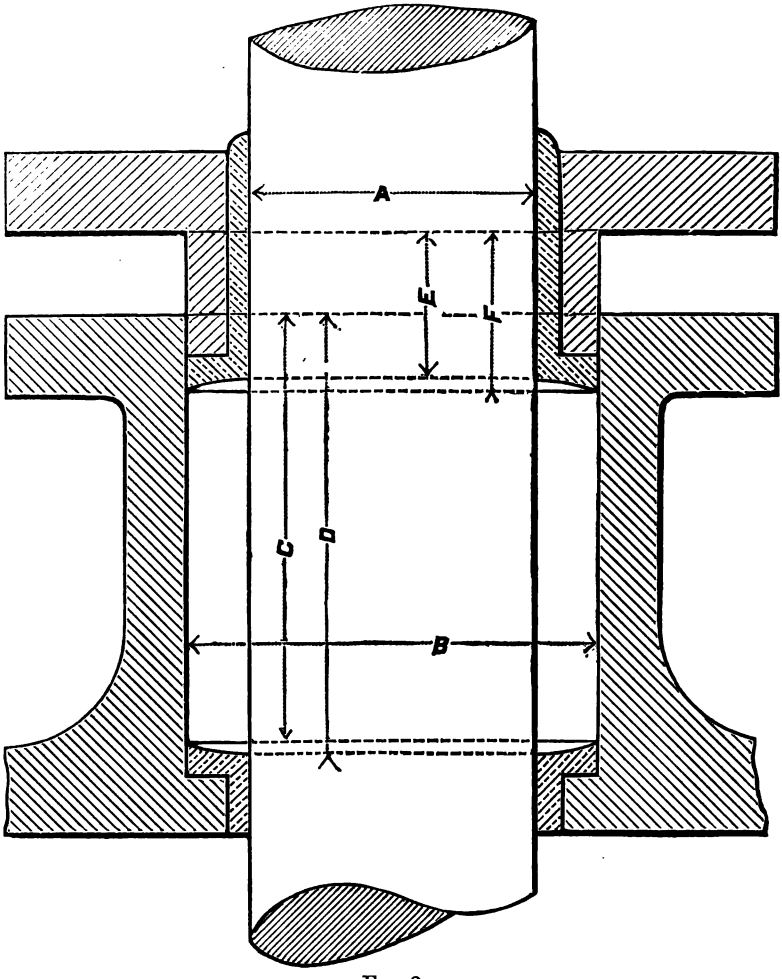

FIG. 2.

existing pit or other pumps. It is not liable to get out of order, and adjusts itself to any slight variations in the diameter of the rod

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or plunger, and, unless they are very bad, soon wears into any grooves on old rods or plungers. It is very durable, and there is no reason why it should not last as long as the engine or pump, with ordinary repairs. The first cost is very low, and would, in comparison to the cost of ordinary packing used, soon repay the first outlay. The packing was first tried on a pair of 32-inch winding engines on the piston rod, which was 5 inches diameter; and, although this was the first one made, and is very imperfect compared to the one that has just been described, it has been in practical work for over six months, and has caused no inconvenience whatever. There is another since applied to a 24-inch air compressor at the same colliery, which has been in use for over six weeks without any signs of leakage whatever, and in both instances the rods are in better condition than when working with the best and most expensive kinds of fibrous packings. The pressure of steam and air in these cases, respectively, is about 55 lbs. Several other packings have been made, and there is one on a locomotive which has been in use for about six months under a pressure of 120 lbs., which is perfectly tight, and has not been touched since it was put in, and all others are giving every satisfaction.

Figure 2 shews an ordinary stuffing-box and gland, indicating dimensions required to fit new packing into an old stuffing or packing-box. A is the diameter of the piston rod or plunger; B, the internal diameter of the packing box; C, the least, and D, the greatest depth of packing-box; E, the least, and F, the greatest depth of gland from the underside of the flange. Given the above dimensions a set of metallic packing suitable for any packing-box of an existing engine or pump can be supplied.

The packing is being made by Messrs Fleming, Bennet, & M'Laren, coppersmiths, Elliot Place, Cranstonhill, Glasgow.

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CALIFORNIA STATE MINING BUREAU SAN FRANCISCO.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE

ROOMS OF THE CHRISTIAN INSTITUTE, GLASGOW,

9th October, 1880.

JOHN M. RONALDSON, Esq., President, in the Chair.

THE minutes of the last General Meeting were read by the Secretary, and confirmed.

The following gentlemen, who had been duly nominated, were elected by ballot as ordinary members:—

W. WHITE, Burntbroom Colliery, Broomhouse.
A. G. BROWN, 42 James Watt Street, Glasgow.
WILLIAM LITTLE, Gateside Colliery, Cambuslang.
WILSON RENNIE, Gateside Colliery, Cambuslang.

The following discussions then took place:—

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DISCUSSION OF MR KEAN'S PAPER ON "A NEW LONG-DISTANCE ELECTRIC BELL."

The PRESIDENT said it was desirable when they used electric signals that they should be efficient. There was nothing more tantalising than to ring for half-an-hour, and get no answer. To have a signal that could be depended on was a very desirable object, and apparently, from what they could learn, this was the case with this apparatus.

Mr KEAN said they had twenty-six bells of the kind described working, and they seemed to be giving satisfaction. He would have been very glad if the members who had been using them had expressed their opinion, more especially as to what faults they had to find with them, because in a new thing they wanted to get at the bottom of any defects that might be discovered in practice, so as to remedy them before they sent out any others.

The PRESIDENT proposed a hearty vote of thanks to Mr Kean for his kindness in bringing the subject before the Institute, which was heartily accorded.

DISCUSSION OF MR MARTIN'S PAPER: "PROPPING AT STRAITON AND PENTLAND."

The PRESIDENT, in reference to the statement on pp. 61-62 that 9ft. was sufficiently near for props to be to the face, asked if the miners could not have worked with them any nearer. What was the practical difficulty?

Mr MARTIN said they required to put in a very heavy blast to bring the shale down, and if the props were any nearer they were either knocked out or broken.

The PRESIDENT—Was it not possible to put them in again after being knocked out?

Mr MARTIN said they never had an accident from a fall of roof between the face and the line of props, and he supposed the miners thought they would be better employed otherwise than in carrying and putting up props to blow them down again.

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The PRESIDENT said this was a subject he had been paying very much attention to, more especially recently, and the longer he lived the more he was convinced that a great deal could be done to make their working faces more secure, without the expenditure of an additional penny in prop wood. For instance, there was nothing more common, in going into a stoop and room working, which was perhaps 15 ft. wide, than to find it beautifully secured with props away down the road with crowns, right down the centre, and perhaps two rows of props on each side, but when they came to the actual working face they would find no props within perhaps eight, ten, eleven, or even fourteen feet of the faces. He would ask what props were put in for? Was it to secure the roof? If it was, surely common sense should induce men to prop the part where they were exposed to danger. Instead of securing it so carefully away back where the men did not spend a hundredth part of their time, he thought it ought to be the actual working face that should be secured. He found this most systematically gone into in many mines. Also, in longwall, they would find lots of crowns along the roads and props in the waste, while at the actual face, in many instances, there were no props within 6ft. of the face. Now, in longwall working, the miner did nearly all his work at the coal face, and, if a fall took place, the chances were that he happened to be below it, while in the waste it did not matter so far as safety was concerned whether the roof was secured or not. He had the curiosity to look up the accidents reported during this present year, and he found that of the total number reported in the Western District, exactly 40 per cent. (which was much about the usual thing), took place through falls. Of the whole, 23½ per cent. were by falls of roof; and of these falls of roof, 16 per cent. of the whole number reported from all causes was due to falls of roof at the actual working face or at the road head close to the coal. He supposed other districts would bear out the same figures, and he thought it was most important that more attention should be paid to the propping at the actual face. Take, for instance, many seams where the roof was notoriously bad, such as the Ayr Hard coal at Annbank. The roof there was admittedly bad—full of lipes. What

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happened? They would get crowns laid up as close against the coal face as they could get them, and the men confessed they required to do this. They blasted down the coal, and the props were frequently knocked down, but they were put up again. At Cumnock the Main coal workings in the Eglinton Iron Coy.'s pits had a very bad roof. The roof was so bad that they could not drive the main roads in the seam, but had to drive them in a thin seam underneath. There, they would see crowns as close to the face as they could put them, and he was sure there would not be more than three feet square without a prop. There were also crowns across on the road where the rails were. What was the result? There were very few accidents—a mere tithe of what happened where the roofs were comparatively good, and that just showed what could be done by a thorough system of propping close to the face. Of course, it was like asking a miner to have a tooth drawn to ask him to do so, but he thought much could be done by their managers in the matter. He did not ask for a single penny more to be spent on props, because he believed throughout Scotland there was an ample supply of propwood used. What he asked was just to put it in a little nearer to the face. This was a point he wished them to discuss, because he thought it was of very great importance.

Mr MARTIN pointed out that Fig. 4 was not correctly shown. It showed the face looking up the shoot, when it should be horizontally across, and the ends of the prop lids should have been shown instead of the sides.

Mr FAULDS supposed the cause of the systematic propping described was that Mr Martin had a bad roof.

Mr MARTIN said the roof was tender, but it had this advantage—it was very flakey; it was not lipey like that at Annbank. They found the roof generally good at the face, and that, back a stoop-length, it came crumbling down, and required all the props they had put in.

Mr ROBERT WADDELL said, as he understood systematic propping, it was of more importance in a good than in a bad roof. Bad roofs looked after themselves. The danger was in a better roof. A good roof was depended on in that case.

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The PRESIDENT—And experience shows it is not always to be depended on.

Mr RALPH MOORE said his feeling had been all along decidedly that there ought to be propping at regular intervals whether the roof seemed to require it or not. The most experienced miners frequently failed to detect the security of the roof from appearances. Every fall that took place showed this. If they had props set systematically, say 4ft. apart, as he thought there ought to be, while there might and always would be falls, they would ensure there would be none except between the points supported. It would not at all interfere with the necessity for the miners' observation of the roof that would still be necessary. In his experience, he had found falls generally happen when the props were more than 4ft. apart. They had falls coming from lipes in the roof or something of that kind, which could not be detected in nine cases out of ten. If they had regular intervals of propping, they would introduce a system by which the fireman, or whoever looked after the propping, could say—"This is 4ft. apart, and you ought to have a prop here." It did not necessarily mean that these props were never to be removed, but it said—"This is a system you should adhere to." As one gentleman had said, it was much more important in a good roof than in a bad one to keep up the system.

The PRESIDENT closed the discussion, and hoped the example set in the paper by Mr Martin would be followed by others in bringing before them their different systems of working. It might be said they had thrashed out propping very well, seeing they had had a Propping Committee; but he thought there was a great deal still to be done in the way of trying to preserve the lives and limbs of their miners, who, as they all knew, with the very best intentions, frequently get themselves hurt when such a thing might be avoided. He proposed a vote of thanks to Mr Martin for his paper, which was cordially awarded.

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DISCUSSION ON MR M'LAREN'S PAPER—"WORKING THICK COAL SEAM BY LONGWALL AT BALGONIE COLLIERY, FIFE."

The SECRETARY read the following communication from Mr John Thomson, Lumphinnans Colliery:—Mr M'Laren in his paper suggests that those members who are acquainted with the various systems would come forward and contribute to the discussion. I do not intend to dispute the merits or demerits of the system adopted at Balgonie Colliery, but to speak of two different methods by which a very thick seam, the Lochgelly Splint and Parrot seam is worked in this district.

The section of the seam is as follows:—

	Ft.	In.		Ft.	In.
Roof, Coaly Blaes and Blaes. ...	6	0	to	20	0
Head Coal, ...	2	0			
Splint Coal, ...	4	0	to	5	0
Cherry Coal, ...	0	6			
Fireclay, ...	0	0	to	3	0
Doggar Stony Coal, ...	0	3	to	0	6
Parrot Splint or Rough Coal, ...	0	7	to	1	0
Parrot Coal, ...	0	6	to	3	0
Rough Coal, ...	1	0	to	1	4
Sclit, ...	0	4			
Pavement Bands.					

The gradient of the seam is very irregular, being from 1 in 5 to 1 in 1¼. The principle in this case is the regular longwall working. In the first working the seam is taken away to the bottom of the cherry coal; the levels are driven 10 yards wide, the holing being generally done in the fireclay; this, with the dross, packs the waste. The holing being done in the fireclay, renders the dross useless to send to the pit bank, and as it is necessary that no empty space be left in the waste, it requires the whole of the rubbish to pack it. Old wood is used generally, put in lengthwise on the roadside, along with the fireclay for buildings. Main headings are driven every 70 yards, and branches put in level course off these every 12 yards, and worked by the cut chain principle. This is continued to the boundary or march. Then the second working is begun.

In the second working the waste has subsided so much that the

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most of the roads in the first working are entirely done. New ones, however, are easily made, brushing down the coal out of the roof for height; and commencing at the far end, the coal is worked back, the one place being kept a short piece in advance of the other. This system has been adopted here lately, and so far has given good results. As I have mentioned previously, great care must be taken in having the waste properly packed, as in any seam where spontaneous combustion takes place, it is where a space is left that it originates.

Another method of working this seam where no stone or fireclay intervenes, and which has been worked to considerable advantage here and at Cowdenbeath Colliery, where it was introduced by Mr David Anderson a number of years ago, is what is termed the Panel system, and is illustrated by the accompanying figure. In the first working the coal is taken away to the cherry coal. Levels are driven 8 feet wide and pillars left on the rise side 30 yards square. In forming the ends those stoops are also driven 8 feet wide, in consequence of the gradient being so steep that a double road is necessary. The panels are generally formed every 140 or 160 yards. When a panel is to be formed a main heading is driven 8 feet wide, and pillars left or formed on each side, 30 yards square. The heading is driven up say 80 yards, thus forming two pillars on each side, and well advanced into the third. The regular working is now begun. The places are driven 15 feet wide, and small coal pillars left from 6 feet to 8 feet square. No dross is filled in this working. Wood pillars are put in, generally three in each place, this being sufficient to allow the roof to gradually subside. This is continued up to the 30-yard level above (the coal being run down by gurdie and cut chain), when this is cut off and the coal brought out here. Whilst working this other 30 yards lift, after proceeding say up 20 yards, the workings abandoned below having subsided from a waste of 5 feet at commencing to a height of 2 feet 6 inches, the second working is begun, height being taken out of the head coal for drawing roads. A margin of 10 feet is left next the upper level for protection, and the wood pillars are taken out and all the dross filled, the small coal pillars being now crushed to dust. The coal is now

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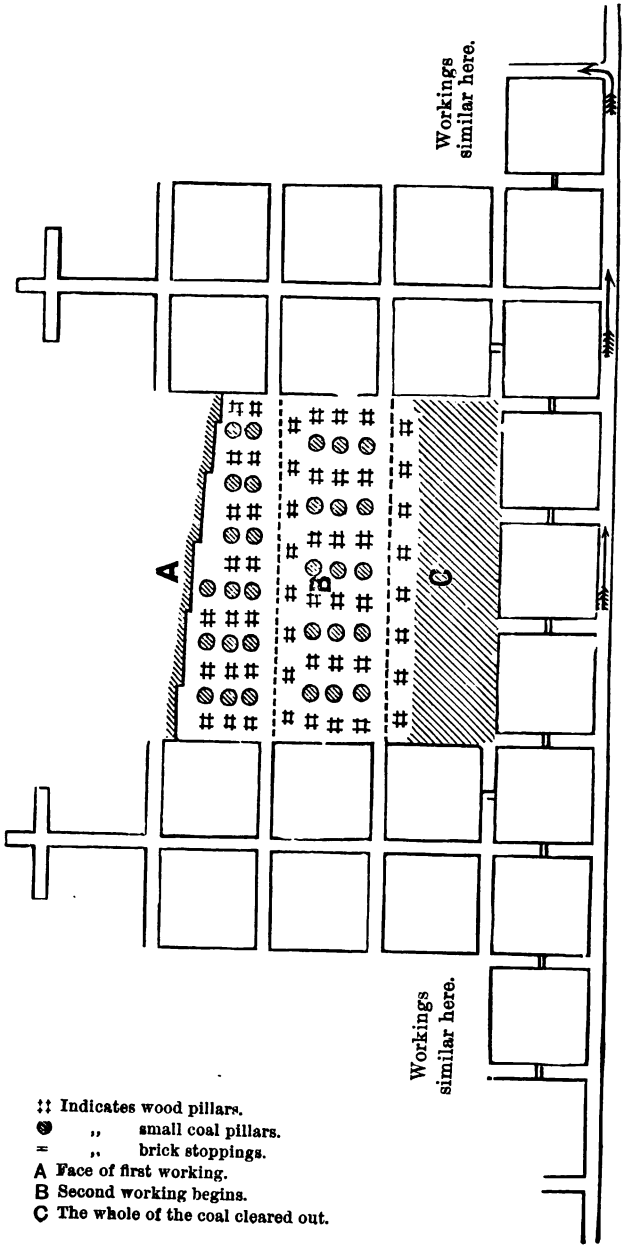

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worked back, and every place of ingress built up, allowing no air to travel through what has been worked. After the boundary has been reached the large pillars forming the barriers are worked back.

The advantages to be gained by this system are, that all the coal is got, and where spontaneous combustion is to be dreaded, the fire can be easily shut off and a level driven higher up and opened out anew.

The SECRETARY read the following communication from Mr Andrew Crookston, Wemyss Colliery:—

The system of working the Dysart Main coal as described by Mr M'Laren, and as being worked at Balgonie Colliery, has been in operation at Duncan's Pit on Wemyss Estate since 1884, with this difference that our roads are only 8ft. wide instead of 10ft. (see page 66); also, we only allow a foot of the head coal to be brushed by the colliers in the first working.

Again, the roadside buildings in our case are put in 3 to 4 yards across the face, the open cundies being in the centre of the walls. The roadside buildings consist of the Myslen stone, mixed with old wood, broken props and slabs, in lengths of 4ft. 6in., packed with the daugh and dross from the coal. The colliers stow the overplus *debris* into the open cundies. When working the upper leaf back on the waste of the first working, it is found that the waste is so thoroughly settled down that there is no vacancy where the cundies were formed in the first working.

In the upper leaf or second working, we take all the coal out to the top of the spar coal with the coal faces in a line. I can see no advantage in keeping the one place 5 yards in advance of the other, as it would in many places cause extra to be paid to the colliers for having a ribside, and there must be difficulty in keeping the faces open for ventilation. I know in our case it would be so.

At page 67, it is stated that the only spar coal that is got is what the workmen allow to fall behind them. When this does occur, it is only then it is filled and sent up. Here there must be a great loss of valuable coal, as 15in. of coal will yield 1600 tons per acre, and suppose they got one-third of it, still there would be a loss to the coal proprietor and also to the country at large

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of over 1000 tons per acre of the upper coal wrought, which is a serious matter. Therefore, I cannot see how Mr M'Laren can claim (page 70) for that method of thick coal working that the whole available coal is got.

We are at present in Duncan's Pit working a section of the second or upper leaf in the same direction as we have worked the under leaf or first working, and by doing so we find that the coal is much easier got by the colliers and in larger pieces, and a saving in hewing rates is effected.

The section of the Dysart Main coal in Duncan's Pit is identical with that of Balgonie Colliery.

The SECRETARY read the following communication from Mr David Smith, Dalmellington :—I quite agree with Mr Jamieson's method of working the coal as described by Mr M'Laren. In addition to our three section working, as referred to by the chairman, I worked the Ayr Hard coal in two sections very successfully about thirty years ago. The cause of my adopting this plan was a very soft roof we had to contend with. By leaving on the top or head coal, and brushing 3 feet out of the pavement for building with, the dross and 10 ins. of shale in the coal seam stowed the working well. In the outcoming working the turning over of the stowage, and the re-building with it, allowed the head coal to be dropped without any holing in the coal. The leaving on of the head coal gave a good roof in the first working, and in working backwards we were building up and leaving the bad roof behind.

The SECRETARY read the following communication from Mr Dugald Baird, Leven :—In the criticism which followed the reading of Mr M'Laren's paper on Thick Coal Working at Balgonie, reference was made to the system of working a thick coal at Leven Colliery. Mr M'Laren was right in saying that the second working was in the same direction as the first working.

A look at this section, which is of the Chemiss coal seam, will show that as regards thickness of coal and thickness of stone in the seam, it is almost similar to that in Balgonie, although, of course, it is not the same seam.

The first working, which takes one half of the total thickness

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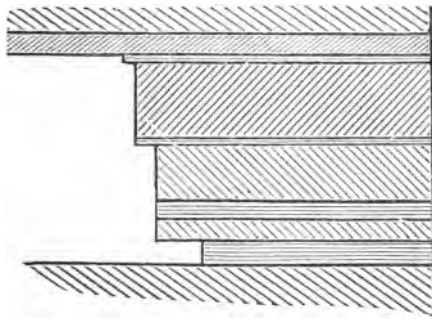
of coal and 90 per cent. of the total stone in the seam, is worked in the usual longwall style.



	Ft	In.
Fireclay.		
Coarse Coal,	1	3
Fireclay,	0	2½
Coal,	3	6
Fireclay,	0	1½
Coal,	2	6
Stone,	0	10
Coal,	1	0
Fireclay,	0	9

The second working follows up in the same direction, and by the same roads, but from 20 yards to 10 yards in the rear of the first working. It also is worked in a similar manner, only the holing is in the waste of the first working, and is taken thick enough to produce stowing enough for the waste. The buildings of the second working are formed of the stones which formed the building of the first working which have been displaced by the weight; any deficiency is made up by wooden pillars, but unless in main roads few of these are required.

It is found that if the faces of the second working are more than 20 yards in the rear of those of the first working the top coal is too much crushed, and the waste too firm for easy holing; while on the other hand, if the second working faces are less than 10 yards in the rear of those of the first working, the whole working is not sufficiently settled down for the miners' safety, nor does the coal come off without much labour, and then not in so good condition.

This system is obviously an easier and less expensive one than that practised at Balgonie, but would not be suitable there, because—First, owing to the liability of the Balgonie seam to spontaneous combustion, it is necessary that the field should be formed into panels, whereby the fire, should it break out, can be isolated from the other panels, and also whereby the waste formed in an exhausted panel or section can be totally deprived of a current of air, and so be damped down to prevent the

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possibility of a gob fire; and, Secondly (unless the panels were made larger than would be safe for gob fires), owing to the harder and stronger nature of this roof, the waste of the first working would not be sufficiently consolidated to allow of the second working following the first.

In the Lochgelly and Cowdenbeath districts, the Lochgelly Splint and Parrot working has long been carried on, on the same style as that described by Mr M'Laren, and is still being carried on. This seam, like the Balgonie one, is also liable to gob fires.

Best results are got from this method when the first working contains about 40 per cent. of rubbish above or below the coal, so that the working may be well stowed; where there is a scarcity of rubbish a great deal of wood requires to be built in to steady down the top coal when the crush comes on; otherwise the top coal gets much crushed, and the roof of the second working made unsafe.

Where there is little rubbish along with the coal a system is usually adopted whereby small stoops of coal are left in the first working. These stoops are left just large enough to carry the weight of the roof for a short time, and then to collapse, gradually allowing the roof to settle down slowly and regularly on the top of whatever rubbish and small coal there may be in the waste, and are assisted in so doing by a few slim hollow wooden pillars, 4ft. square, which are packed full of rubbish or small coal; the size of the coal pillars, and the width of rooms depending, of course, on the depth from the surface. This system, unless where there are hitches, leaves the top coal in very good condition.

There are other systems of working thick coals practised in Fifeshire, but these are the principal and best. One system is not applicable to all. Each seam, or even parts of the same seam has its own peculiarities and features, the coal being soft or hard, being at different depths from the surface, having soft or strong roof or pavement, being associated with material not put out, and being more or less liable to spontaneous combustion, the whole of which must be considered in adopting a system of working. The system described by Mr M'Laren as practised at Balgonie I have no doubt is quite suitable for

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Balgonie, but it is certainly not a new system, even to Fifeshire.

The PRESIDENT asked Mr M'Laren why, in the second working, one face was five yards behind the other. Was it for fear of a break going along the face?

Mr M'LAREN said the reason was not to have the weight along the whole face seeing it was so steep. He asked the reason and that was the reason given, which he thought sufficient. Mr Crookston said in his communication that there is a rib-side, but there could be no rib-side where they were taking out a stoop with both ends open.

The PRESIDENT—Do you think he has ever tried them with one face less than five yards behind the other?

Mr M'LAREN—Oh, yes; I think I saw some only a few feet. He has measured some five yards; that was the farthest.

Mr RALPH MOORE said this system, or something like it, was begun about twenty-five years ago at Balgonie. He forgot who was the manager. There was this difference, that both workings went in the same direction—the one being about a hundred yards before the other. The faces were cut off by cross roads, and whenever there was a new cross road cut the old cross road was used and the upper coal taken out. It was working very well then. One of the gentlemen was quite right in saying in his communication that the Lochgelly Splint, and he thought the Parrot coal were worked in the same way for more than that period—before he (Mr Moore) became inspector. They used, before they had much stowage, to have these small pillars which were crushed down to the Parrot coal. It worked amazingly well; there was very little coal left. The Chemiss seam was in three pieces. He thought they worked all the three, the one after the other, but not keeping 20 yards behind. They worked just the one into the other, using the old roads as far as applicable. Then he had seen a similar system in working the Virtuewell coal, where they worked the ironstone above it. The Virtuewell was about three feet thick, and there was a rib of stone above it, and then the ironstone. In that case they worked the Virtuewell coal first to the width of a place, and propped the roof up very carefully. Then they knocked out the props, and only the intermediate space fell, and then they got the ironstone

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out. In that way the whole ironstone and whole coal were got. Formerly, when there was a thickness between the Virtuewell and the ironstone, they used to work it back and put up holes every two or three yards and brought down the ironstone out of it. There was no doubt that the system of working these thick seams by longwall was to work them in two or three lifts. Talking of spontaneous combustion—at Largoward, where the coal was liable to spontaneous combustion, sometimes they had a fire within 20 or 30 yards from the face when working at it. They built a double wall on the roadside, and betwixt the walls they had 12 inches of sand, and that seemed to virtually keep off the air from the burning. If the fire came too near the face, they built a similar wall across from one road to another, and that seemed to completely isolate the fire. He did not know if it was working just now, but it was working about twenty years ago. The use of the sand seemed to be quite sufficient to stop the progress of the fire. He thought they worked longwall in Fife better than in any place he had seen it in the Eastern district. They also used to advantage the system of cut chains, which was peculiar to Fife. At least, it was there he first saw it a great many years ago. It was an admirable system for dealing with steep workings and longwall, and it was remarkable how ingenious their applications were. Sometimes they had one wheel at the top for seven or eight roads. Occasionally they had a small wheel at each road, and instead of having the whole length of chain working from top to bottom, they had it from that point to the bottom. They had them nicely arranged. Then, where it was very steep they cut out flat for the hutches to run on, and they had rails stretching from the one to the other when the road was clear. It was a very ingenious thing, and if any of the members had not seen a Fife longwall working, he would advise them to see it.

The SECRETARY said he was sure that the system of working detailed in Mr M'Laren's paper, although known in Fife and a few other parts of the country, was still new to many of their members, and that the paper would be read with great interest and the discussion as well. He thought they were indebted to Mr M'Laren for bringing it before them. He did not suppose

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Mr M'Laren pretended to describe the system of double working as a novelty, but wished to make known the advantages that had been secured in certain arrangements of that mode of working to suit special circumstances. Following up Mr Ralph Moore's remarks, he might mention that about twenty-five years ago the Virtuewell coal and Roughband ironstone above it at Legbrannock Colliery, which were about five feet apart, were worked by a double working, the coal being worked first and the ironstone afterwards worked backwards, the coal roads being used for the purpose.

The PRESIDENT said a similar system had been introduced within the last six or eight years at Muirkirk. Formerly the thick seams were worked stoop and room, but the present manager of the Eglinton Iron Coy. had introduced working by longwall in two sections. The system of working was somewhat similar to what Mr M'Laren had described, which, he thought they all knew was not a new system, and he did not pretend that it was a new system.

Mr M'LAREN said the reason why he brought the paper before them was that he was much struck with the system of working. He had asked Mr Ballingall in reference to a system tried at the colliery some 25 years ago, and referred to by Mr Moore. The system was to go forward with first and second workings. It was fairly successful for a time, but at last was given up for what reason he did not know. He was very much pleased to see the members interesting themselves in the subject. That had been his aim in bringing it forward. He was quite sure the young men knew nothing about it, and he asked Mr Jamieson to bring it forward. As he would not do so he (the speaker) said he would take it up. He had asked Mr Anderson, of Cowdenbeath, to give his system for working the Lochgelly Splint and Parrot seam. In the first working of his system, small pillars, 6 feet square, are left in, and these were very much crushed. He was indebted to the members for contributing to the discussion.

Mr HUGH JOHNSTONE asked to be allowed to supplement what Mr M'Laren had said as to the former method of working the Balgonie thick seam and the present method. The distinguishing feature of the present method was the back working of the upper leaf. He understood in a former working the upper leaf

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was carried forward, and time after time they had to stop and build it off in consequence of spontaneous combustion. If his information was correct, they found that that almost invariably set in at a rib-side in an old roadside building, or in an open part of the goaf where the roof had not fully settled down behind the upper leaf working, that was about twenty yards from the working face. Mr Jamieson claimed, in working back he had overcame that difficulty, and there had never been a fire in the pit since he had adopted that system. Mr Baird was correct as to his description of the system at Leven, and while that system is perfectly applicable to the seam at Leven, it would not be suitable at Balgonie. For this reason: if the upper leaf was carried forward, the roads would require to be rebuilt. They were thus left standing open, and in this open space there was great risk of spontaneous combustion setting in. In working back, Mr Jamiesen used the roads made in the lower leaf-working, only taking down as much head-coal as was necessary to make a good drawing road; and as the working-faces in the upper leaf progressed the part of the road thus cut off was allowed to close. As would be seen in Fig. 4, p. 68, the stowage in this working was continuous along the face, and consequently when the roof settled there was absolutely no open space left in the goaf. That, he thought, was the secret of success in this working. The relative position of the working-faces in the upper working was more or less determined by the nature of the roof and the extent to which it was affected by the former or lower working. In many cases the faces were perfectly continuous. One thing that required to be kept constantly in view when considering the working of this seam was the risk of spontaneous combustion. As to what caused it in this and many of the other seams, their ideas were extremely hazy. Every one thought he knew all about it, but when he tried to formulate his ideas, he found that he really knew very little, and he thought it would be of great importance if the few who had a thorough experience in dealing with goaf fires would join in the discussion. From that they would ascertain not only what caused these fires, but how best to deal with them when they did break out.

The discussion was adjourned.

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DISCUSSION OF MR F. J. ROWAN'S PAPER: "MELDRUM'S FORCED COMBUSTION FURNACE FOR BURNING SMALL COAL UNDER STEAM BOILERS, &c."

MR ROWAN said that, at his suggestion, the Messrs Meldrum had tried the application of this system to utilizing the waste from coal-washing machines, and he heard from them that, at a colliery where it had been tried, it had been so successful in the first boiler that there were other four boilers being fitted up with it.

Mr RALPH MOORE asked if Körting's Blower was not somewhat similar.

Mr ROWAN answered in the affirmative.

Mr G. A. MITCHELL asked if Mr Rowan would give the cost of the machine, and the cost of the upkeep.

Mr ROWAN said it was impossible for him to give a general figure that would apply in every case, because of his short experience of the system. He had only been working at it for two or three months, and during that time there had been as many different kinds of business as there had been months, and consequently it was impossible to give more than a general idea. For an ordinary Cornish boiler it cost £30, and as in this apparatus there were no weak parts, he did not see why it should not last as long as the boiler.

Mr RALPH MOORE said, in burning anthracite coal, they used this force blast. He saw in America last year an arrangement very like this. They used it because they required more air for the anthracite coal than they could draw with ordinary draught. That was the ordinary system in Philadelphia and Reading. There did not seem to be any objection to it.

Mr ROWAN said Körting introduced what he called an "undergrate blower," but it was not very successful, he supposed on account of the air and steam being out of proportion.

Mr RALPH MOORE said he thought he saw the system in operation with anthracite coal in Wales lately. It might be different. They took the steam a little way in. Was there anything in the bar?

Mr ROWAN said the bar was designed for the purpose of using

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with small fuel lest it should be lost by dropping through, and yet having a sufficient air space. The form of the bar had been arrived at after a good deal of experiment in England. Here they had of course very little experience of it as yet.

Mr COWAN asked if Mr Rowan would tell them how the bars lasted.

Mr ROWAN said they were found in England to last very well. The steam prevented their liability to destruction by clinkering, and the decomposition of the steam at the surface of the bar kept the bar cool.

Mr COWAN said that had been a difficulty with forced combustions,—the getting of the bars to stand.

Mr ROWAN said he did not know that there was any other plan of forced combustion than this which was worked with steam jets. It was usual to work with air blast alone, and that intensified the combustion and wasted the bar.

The PRESIDENT said he had seen the waste gas from the oil works brought in to the boilier with jets in it, and the gas and the steam blowing in together below the boiler. He had seen the rivets actually red-hot on the crown of the flue with the intense heat. It was a design to use the waste gases of the oil work, and the steam was used to force it in.

Mr RALPH MOORE said in the blowers he had seen the object was two-fold,—first, to send in sufficient air ; and, second, steam to prevent the coal from closing up the bars.

Mr FAULDS asked if the machine was more applicable to Cornish boilers than to egg-end boilers ?

Mr ROWAN said it was not. It did not matter what was the design of the boiler. All that was required was that there should be sufficient space in the ashpit to permit the introduction of the steam jets. He was yesterday inspecting two large boilers of locomotive design. They were of peculiar shape, and had not much opening to the ashpit, but there was sufficient space to introduce the jets, and that was all that was wanted.

The PRESIDENT said one great merit evidently was, they had no smoke. That would be a good thing if applied over Glasgow.

The SECRETARY said he thought this matter appealed very

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directly to the pockets of the coalmasters. If it were a good thing, he had no doubt it would be introduced largely, and that very soon, because there was a large amount of inferior fuel about pits consequent on coal washing and otherwise.

The PRESIDENT said it also appeared to have found out a weak point in the coal washing system. Mr Rowan said the refuse was found to be available for fuel. If this was the case, what was the use of washing the coal at all.

Mr ROWAN said the dust from the settling ponds he did not think would pay them to transport. It was to enable them to use it as fuel instead of wasting it that he proposed this apparatus. He might say he was led to look out for something of the kind from the discussion that took place on his paper on "Gas-fired Boilers." Mr Dixon, in his usual practical way, asked some questions on this same subject of utilizing coal dust, and it was apparent the large column of fuel in the gas producer was against its use in producers. He was convinced a special appliance would be required, and, in fact, described a similar appliance to this which had been worked out in Germany. It was a little more elaborate, but had been very successfully used with small coal dust. He then heard of Messrs Meldrum's plan, and made some enquiry, and found it was practically a British form of this German system of firing. Haupt, he thought, was the name of the German who introduced it there. He heard from Messrs Meldrum yesterday, about a lot of new applications, and that a large firm of colliery proprietors had started with it. They had now in use 17 boilers and 27 furnaces. Of these 25 were at their collieries, and they used a mixed fuel—one-third coal dust and two-thirds coke. There was no doubt at all in his own mind that the stuff which they threw away in their settling ponds or in the neighbourhood of pits was useful for this class of apparatus. In the case of gas works, to which it was easily applied, they used their riddlings from the gas coke which contained about 30 per cent. of combustible material—the rest incombustible, and the boilers at more than one of the gas works where it was in use were fired with nothing else.

The discussion was adjourned.

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In the absence of the author, the discussion on Mr A. M. Grant's paper on "An Improved Patent Metallic Packing for Piston Rods and Pump Plungers" was deferred till next meeting.

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A SYSTEM OF WORKING SHALE 6FT. THICK WITH A TENDER ROOF AT AN INCLINATION OF 30° AND UPWARDS.

By Mr Arch. Livingstone.

Reference is made to Plate II. in Illustration of this Paper.

Searching for the shale may be done by a series of small bores, as shown in figure 1. If bore No. 1, put down well forward in the field, be unsuccessful, bore No. 2 may then be put down, care being always taken to be as far back with the situation of the bore as to come as nearly as possible to the stratum in which the former bore stopped. At the same time care must be taken not to go too far back, which could be easily done, and so miss some of the beds, as will be seen from the position of the strata. But I think the better way is to go well forward and put down a diamond bore, and show the different seams properly. Shale is so like blaes that it is difficult to distinguish it, and, as to quality, it is only by means of the diamond bore that samples sufficient for analysis can be got of any seam got in the bore. The position of the diamond bore is shewn in Fig. 2.

Suppose the shale to be got, and that it is a seam 6 feet thick with a tender roof, how is it to be opened up and worked to the best advantage? This would, in my opinion, be accomplished by starting away two inclines in the seam, the one as a sinking dook, the other as a winding incline, as shewn in figure 3, leaving a barrier of 30 fathoms along the out-crop to keep the surface water from going into the workings, and also to prevent excessive surface damage along the out-crop. For the first forty fathoms below the barrier 10 fathoms of solid shale should be left on each side of the inclines, and for the second 40 fathoms 20 fathoms solid shale, and for the third 40 fathoms 30 fathoms of solid shale, and so on in this proportion. At the same time in the basin, or as nearly as possible in the basin, in a line with the two inclines, there should be put down a large vertical shaft, suited for and fitted up with large pumping machinery sufficient to drain the whole field. Should the property leased not extend to the basin, the sinking should be as far to the dip as the property leased extends.

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While the two inclines are being driven, and the work therefrom opened up, temporary pumps will be required to drain the field before a connection is made with the vertical shaft. For these temporary pumps compressed air, electricity, or Moore's hydraulic pumps should be used. In the use of pumps actuated by steam, no matter what care is taken to keep steam joints tight, and pipes covered with composition, there is still a quantity of heat given off, which destroys timber and damages the roof. Figure 3 shews in detail the mode recommended of working the shale to the best advantage. The two inclines, Nos. 1 and 2 mines, are driven, one as a dook, the other as a winding incline, in advance of the other two mines, Nos. 3 and 4, with other two mines, Nos. 5 and 6, following, and other two mines, Nos. 7 and 8, following 5 and 6, and so on, each pair of mines being in advance of the other pair by a section of 40 fathoms. From the inclines Nos. 1 and 2 two levels are driven every 40 fathoms and the inclines connected. Then the blocks between are formed into stoops, 50ft. up the hill by 30ft. across the hill, in the first or top section. When this section is formed into stoops, stooping is commenced at the centre, and carried back towards both inclines, but before the stooping starts in the top section, the levels must be driven in section No. 2, and a connection made with the other mines as shewn. Then the stooping may be started and gone on with in the top section until it is completely worked out back to both inclines, when it will be fallen and closed tight. Then section No. 2 may be formed into stoops, and, while this is being done, the levels of section 3 may be driven, and a connection made with the mines, but nothing more done until No. 2 section is stooped back to the barriers on the main inclines, and fallen and closed tight. This precaution is necessary because, with stooping operations going on above and a section of stoops standing formed below, there is great danger of the stoops, &c., beginning to creep down the hill, and when the stoops begin to creep they do not stop until all the openings made below are completely filled. To prevent creeps, therefore, it is necessary to have the section above completely stooped and closed tight; then the section below may be formed into stoops with safety. The reason for making the section only

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240 feet is to avoid having too large an area hanging on stoops at any one time; and, where a large output is required, the only way to get it is to have a good many openings to the surface.

The two systems of stooping which are likely to prove most successful are—(1) Cutting up through the stoops, and bringing back the wings, and (2) Cutting off slices up along the stoop until the stoop is exhausted. The latter system seems the more successful. The timber used in stooping cannot be so easily got in steep as in flat workings, only a small portion of it being got. The best system we have yet got is, as soon as a stoop is entirely out, to set a row of fresh trees nearly close to the stoop that has to be taken next, then to commence taking out the trees, bringing them from the inside outwards, and continuing to take them out until the roof begins to work, when the man makes his escape behind the row of fresh trees down to the road. The effect of this method is that the working closes tight, the roof breaking off by the row of fresh trees set up along the stoop. This is done by the miners about the end of the shift, and should be completed before being left, even if they should have to work later than usual to accomplish it. The roof is then allowed to work and fall till next morning, when it is closed tight, and then the man commences operations on the next stoop. To make it easier for stooping, the shoot for the shale (in the first working) should be put on the side, so that the slice may be taken off the stoop without the daugh or holings of the first working lying against the shale.

In laying off the inclines, I would suggest 300 fathoms between the main inclines. The arrangement would be as follows, and as shown in Fig. 3:—

	Left Solid.	Taken Out.	Left Solid.
Top section, ...	10	280	10
Second section, ...	20	260	20
Third section, ...	30	240	30
Fourth section, ...	40	220	40
Fifth section, ...	50	200	50

According to this, all the shale would be left in as barriers to protect the mines till the pit was reached, but so soon as Nos. 3 and 4 mines were connected with the pit, the whole of the shale

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could be taken out and run down the hill, allowing it to close behind; and at the same time Nos. 3 and 4 could then be commenced, and the barriers on both sides of the inclines taken out up the hill, allowing it to close behind. The same could be done with Nos. 5 and 6, also 7 and 8, &c., whenever they were connected with the pit. In this way nearly all the shale in the field would be taken out, but, in the meantime, the barriers up along Nos. 1 and 2 mines would require to be left to protect the communication with the pit.

In the first working, the stoops should be formed to the sizes understated, and the ends should all be blinded, as shown:—

Top section, ...	50ft. × 30ft.
Second section, ...	60ft. × 35ft.
Third section, ...	70ft. × 40ft.
Fourth section, ...	80ft. × 45ft.
Fifth section, ...	90ft. × 50ft.

The levels should be driven from 6 to 8 feet wide; the places up the hill should be 11 feet wide; and the ends across the hill not more that 11 feet wide.

As the system of propping which is required, and in its main features, has been carried out, was described before the Institute lately by Mr Martin, nothing need be said on that point here. When a connection has been made between the sinking dook and the vertical shaft, the temporary pumps may be abandoned and removed, as no further sinking is required. The water is now pumped by the vertical pit. I shall now give a reason why I think the vertical pit necessary. The inclines crush and creep to a certain extent all the time, and require men regularly brushing and timbering to keep them in order. With rods, guides, pipes, &c., and the rods working, it is difficult to get a pumping incline brushed and repaired. In fact, the expense on an incline for four or five years would sink a large vertical shaft, and an incline does not give the same satisfaction.

To work the shale from the vertical pit, it is well, in the first place, to make a lodgment to hold a week's water, and leave in a bottom stoop 200 fathoms square, driving two levels on each side of the pit and when clear of the bottom stoop, and where a man is able to push a hutch, stoops should be formed 150 feet square,

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as these stoops will require to remain till the upper portion of the field is exhausted, and when the upper portion of the field is exhausted stooping should be commenced at the extremes and stoops worked back towards the pit, allowing the roof to fall and close tight behind. The above system would suit if the pit is sunk in the basin; but suppose the property leased does not extend to the basin, then two levels may be driven off each side of the pit, and connections driven up-hill, joining each of the mines with the levels of the vertical pit. The shale could then be run down the hill to the vertical pit, but on no account should the working of the shale be begun down there. Only the connections should be made and the system shewn in Fig. 3 continued.

A vertical shaft fitted to raise 1000 tons per day is equal to four inclines, as about 250 tons in ten hours is about their maximum output, and that is with coupled engines ranging from 20″ to 30″ cylinders, 1½″ plough steel ropes bringing up from six to eight hutches on the rake—three drawbars and three couplings on each hutch. The centre drawbar and coupling are made very strong, and they do the actual work. The two side drawbars and couplings are a little longer, and should the centre drawbar or coupling break the two side ones bring the rake up. The place and time when the greatest strain is on the drawbars is when the rake is passing over off the inclination to the flat at the top of incline, as shewn in Fig. 4. To ease this the angle at the top should be made as obtuse as circumstances will permit.

The other system of winding from inclines is by means of a carriage. When the inclination goes above 35 degrees, the carriage, as shown on Fig. 5, is to be preferred, and when the inclination reaches 45 degrees, the carriage becomes a necessity in order to prevent the shale tumbling off. Another advantage of the carriage is that it is always on the inclination, and so the rope does not get the snaps that sometimes is the case when the pitheadmen do not push the hutches over the top of incline as quickly as the engineman gives out the rope from the drum. To ventilate the workings a fan is most suitable. A furnace has not any chance of ventilating in steep workings, and an effort should always be made to have a duplicate in some form or another in case of accident to engine or fan.

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I may now say that at Pentland and Straiton a few systems have been tried, and amongst these longwall has been tried with a certain amount of success. The seam is worked up the hill, but it is difficult to get out the curly shale and to work with safety, because if the curly shale is taken out the roof is so friable and the shale itself is so tough and strong that when the weight comes on the roof breaks, with the result that the place closes, and the place is so high it is dangerous for the miner, and he does not care about facing it at all. If the curly shale be left on it bends and does not break, and the working is safer for the miner. But the curly shale is the most profitable part of Pentland shale, and must be taken out. Working by longwall down in the lower sections, say, at a depth of 200 fathoms vertical, taking the curly shale out, is a problem still to be solved. In the top sections, say, to a depth of 50 fathoms vertical, any system nearly may be adopted with success; but in the lower sections, where the pressure becomes greater, the case becomes altogether different.

In the longwall working there are 3 feet of inferior shale taken out which makes the place between 9 and 10 feet high. This inferior shale helps to stow the place, and along with this inferior shale there are wooden pillars put up along each side of the shoot and along each side of the level. These pillars when built are between 9 and 10 feet high, and thus it will be seen a great quantity of pillar-wood is buried.

Longwall across the hill is also proposed; but I do not think it will be a success as there will still be the same difficulty in working the curly shale, and the inferior shale will be worse to dispose of in this way than going up the hill, as going up the hill it practically tumbles into the waste.

There has also been tried the forming of the whole field into stoops with the intention of starting at the bottom and stooping up the hill, but this did not prove a success, as when sufficient area was formed into stoops, the whole began to creep down the hill and fill up all the openings that had been made. These crushed stoops are being taken out now, but not with the same success as if they had been taken out when they were formed at first.

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And those who have been in connection with shale works will know how important it is to produce clean shale, and how difficult it is where there is a daugh holing and inferior shale above and below the seam. A great help towards getting the shale clean is to appoint a shale inspector for each mine, whose duty it will be to examine each shoot and see if it is clean, also each working face to see if there is a proper quantity of holings stowed, and if there is none of the inferior shale taken out either from above or below the seam.

Crow pickers do good service, but the difficulty with crow-pickers is they only catch a hutch occasionally, and then they can distinguish the daugh from the shale easily, but the crow-picker has to be experienced before he can pick out all the inferior shale, whereas the shale inspector has the chance of detecting all.

Another means of getting good results from shale would be a revolving riddle or a jigger. A jigger would be preferable for taking the fine dust out of the shale.

Taking the inclination of the strata at an average of 33 degrees from the outcrop, the depth of the pit would be 360 fathoms at the point shown on Fig. 3.

The following is a section of the strata above and below the shale. The blaes above the shale is of a limey nature :—

Rock.		
Blaes, ...	68	0
Shale, ...	1	3
Blaes, ...	18	0
Shale (seam worked), ...	6	0
Inferior Shale, ...	3	0
Daugh, ...	0	6
Bastard Limestone, ...	3	0
Ironstone Ribs.		

DISCUSSION.

Mr JOHNSTONE stated that he presumed the paper was not intended as a description of any working actually going on, but described a hypothetical case.

The discussion was then adjourned.

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SAN FRANCISCO.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE

HALL OF THE INSTITUTE, HAMILTON,

20th November, 1890.

JOHN M. RONALDSON, Esq., President, in the Chair.

THE minutes of the last General Meeting were read by the Secretary, and confirmed.

The following were elected by ballot as ordinary members:—

ALLAN CRAIG, 62 Dundonald Road, Kilmarnock.
ROBERT LEGGATE, High Shawsburn, Larkhall.

The following discussions then took place:—

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DISCUSSION OF MR M'LAREN'S PAPER ON "WORKING THICK COAL SEAM BY LONGWALL AT BALGONIE COLLIERY, FIFE."

The SECRETARY read the following communication from Mr James S. Dixon :—

A few years ago I was engaged in an inquiry as to the practicability of working a thick seam of coal in two or more leaves. My investigations led to the conclusion that whether this could be successfully done depended on the supply of material for stowage. After inspecting many examples of such workings, and from full information as to others, it appeared that the proportion of stowage available varied from 29 to 40 per cent. and the proportion between the cubic contents of the excavations made, and the total stowage required ranged from 35 to 45 per cent. In the case referred to, this quantity of foreign material was not available, the only alternative would have been to stow and build with dross and coal, but owing to the liability of the seam to spontaneous combustion this was not considered advisable. In the section given by Mr M'Laren there is 47 ins. of coal, and 20½ ins. of material for stowage, equal to 30 per cent. ; and in that given by Mr Baird on page 97 the coal is 42 in., and rubbish 20½ in. or 32·7 per cent. Mr Baird remarks that the best results are obtained when the rubbish amounts to 40 per cent., which was exactly the conclusion I arrived at, so that in his case 7·3 per cent. would have to be supplied by dross or timber. At page 66, Mr M'Laren mentions that the buildings are partially made up of wood, and the walls partially packed with dross. I should say that these will amount to at least 10 per cent. of the contents of the excavation. I think, in working coal in this manner, the walls should be well filled up so as to allow the top coal to rest uniformly. If dross, which is liable to spontaneous combustion, be partly used as stowage, it should be thoroughly mixed with non-combustible material, and the excavations well filled up so as to allow no spaces to remain after the subsidence. In this I concur with the others who have mentioned it. The members of the Institute are much indebted to Mr M'Laren for bringing such an interesting and practical subject before them; it is, however,

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only in very exceptional instances when the elements of success occur in the proximity of the Pyotshaw and Main seams of this district to allow of their being successfully worked in this way. Where these do exist the method described is doubtless a good one to adopt.

Mr M'LAREN said—Before the discussion is closed on the subject before us, allow me to make a short reply to the members who have contributed to the discussion by communication. I shall deal first with Mr Crookston, principally because he works the same seam, namely, the Dysart Main coal. At page 95 it is stated in bringing the coal back extra will have to be paid to the colliers for having a rib side. If Mr Crookston will turn to page 66 he will find these words—"The ordinary working roads are 10ft. wide, and, in order to give height, the colliers brush down the top coal to the stone immediately below the spar coal." Now, as this is to the roof in the second working, it is plain that both ends are open, and there can therefore be no rib side.

Again, at page 95 Mr Crookston states that a foot of the head coal only is allowed to be brushed by the colliers in the first working for height for roads. Might I suggest to him that it would be to his advantage to take a little more for height, and it would save him brushing his roads a second time.

Great stress is laid by Mr Crookston on the fact that the spar coal is left in, and he bemoans the loss to the proprietor and country at large. It would certainly be an advantage if this coal could be got without the risk of losing the other portions of the seam; but experience has proved that insufficient packing in this seam has led to fires by spontaneous combustion, causing not only loss of the spar coal, but of the whole seam over a large area. If the spar coal had been left in, or, if more coal had been used to pack the waste, the probability is that Mr Crookston would not have had the difficulties to contend with by spontaneous combustion that has fallen to his lot at Duncan's Pit. It must always be borne in mind that when a fire takes place underground it is not so much the coal lost directly by the fire as the large area lost in building it in. I think the members generally will agree with me that it is better to lose 15 inches of coal and pack the waste to obviate fire over a given area, than to take

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that 15 inches and have a loosely packed waste, causing fires whereby one-fourth of the whole seam may be lost, not to speak of the dangers arising therefrom.

Therefore, having these facts before me, I still claim that the whole available coal is got by the system in operation at Balgonie.

In Mr Thomson's communication it will be seen that the system at Cowdenbeath differs from that at Balgonie in so far as small pillars of coal are left in to protect the roof in the first working of ordinary places, and pillars are formed to throw the workings into separate sections. While the panel system has been successfully carried out by Mr Anderson in Lochgelly Splint and Parrot coal he has not been successful in preventing fires by spontaneous combustion.

At page 98 Mr Baird remarks that "In the Lochgelly and Cowdenbeath districts, the Lochgelly Splint and Parrot working has long been carried on on the same style as that described by Mr M'Laren, and is still being carried on." In reply to that I have to repeat what I have stated above in referring to Mr Thomson's communication, and it will be observed that the system differs in at least one important repect, namely, forming pillars to make separate sections.

Mr DIXON is perfectly right as to ten per cent. of dross being what is put into the waste as stowage. He might state that in Fife dross is thought to be of very little value, and they thought nothing of stowing the whole of the dross got from the different seams of coal.

The PRESIDENT said he thought they were all agreed that it was not easy to draw a hard and fast line from the experience of one colliery and say that it might be applied to another. They might dogmatise as they liked, but until they tried a sort of experiment as to the best way of working it they might not be able to hit the right nail on the head. The best way was to try it, and having tried it they were in a position to get the best results. They were indebted to Mr M'Laren for bringing this subject before them. He did not pretend that it was a new mode of working, but it was interesting to have these subjects brought up now and again before them. He closed the discussion, and proposed a vote of thanks to Mr M'Laren.

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The SECRETARY suggested that the discussion should be kept open in case several of the gentlemen should desire to reply to Mr M'Laren, and this was eventually agreed to.

DISCUSSION OF MR F. J. ROWAN'S PAPER ON "MELDRUM'S FORCED COMBUSTION FURNACE FOR BURNING SMALL COAL UNDER STEAM BOILERS," &c.

The PRESIDENT, after it had been stated that Mr Rowan was not present, said he wanted to ask whether any air was introduced below the furnace bars along with the steam. As he understood, there was nothing but steam allowed to pass in below the fire bars, but he would like to know if there was no air admitted.

Mr GERALD said he did not think so. It was simply steam.

Mr ROBERTS said air went in. The velocity of the steam passing in drew in the air.

Mr A. M. GRANT said it acted as an injector. The steam was forced in, and it drew in air below the fire bars. He might mention that at Ballochmyle Colliery they had a lot of very fine dust from the coal washing that they could not burn. His firm were consulted by Mr Hood about the matter. They put a small fan about 10 ins. diameter, driven by a small donkey engine, and led a 6-inch pipe along the front of the boilers, and a 3-inch branch below the furnace, and that proved sufficient. The compressed air was between ½ and 1 lb. pressure, being practically a forced draught.

The PRESIDENT—Was not the tendency in such circumstances to burn the bars.

Mr GRANT—We never had any complaints about it.

Mr ROBT. WADDELL said he had the pleasure of seeing the apparatus at Gilbertfield. His impression was that there was a round hole immediately below the bars, and a steam pipe. It

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was not a blower, and would not draw in sufficient air. Not being a properly constructed blower capable of drawing in more air to cause a sufficient draught was a want.

Mr ROBERTS thought the blower sufficient, but the hole was not large enough to admit a quantity of air.

Mr GRANT thought that, in the arrangement as it stood, the blower was practically an air injector, and was quite sufficient. The arrangement he spoke of admitted plenty of air in ordinary circumstances, because they had only to close the place in front of the door, put in their pipe, and make a steam injector. It might be tried at any time, and a few shillings would cover the whole affair.

Mr WADDELL asked if what was described formed an injector?

Mr ROBERTS said they had a pipe coming from the main steam pipes to the front of the five bars on to which was fixed an injector. I consider the hole in front of the closed ashpit not large enough to admit sufficient air to carry on combustion.

Mr GRANT said they might quite easily remedy that.

Mr ROBERTS—We are trying to remedy it.

Mr GERALD said the system Mr Grant spoke of was simple. If he gave a comparison of the cost it would be of great value to those using it.

Mr GRANT said he had never gone into the cost, but at a first glance there was a very considerable difference. It was apparent to any one. He should say the one would not cost a half.

The PRESIDENT—In your case you have got an air-compressing engine.

Mr GRANT—The engine happened to be there, and the fan was added. He was simply giving the case as an illustration of how the difficulty connected with the combustion of small coal might be overcome.

Mr GERALD said he did not mean the system of compressed air. He meant the system of conducting the steam from the boiler and making a jet below the fire bars.

Mr ROBERTS said what Mr Gerald said was correct. If a pressure could be got up to half an inch water-guage, he thought it would be a great advantage. They fired with small gum, and were not able, owing to its "clinkering" so much, to keep the bars open.

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Mr GRANT said they had got the two systems, and he merely brought up his because it was meant to meet the same difficulty. They could not get rid of this fine coal. It was being thrown into a heap as waste, and the idea was to burn it. The suggestion was made by his firm that they should have a pressure of air below the fire bars, and that had got over the difficulty of burning the small coal. He did not for a moment doubt that this arrangement would do the same thing if properly put down.

The PRESIDENT said there was another point which he thought required a little clearing up. At least, he did not exactly understand it. Referring to the 30 or 40 per cent. of dirt mentioned at page 80, he asked what became of it? Was it blown up the chimney or deposited in the flues, or what became of it?

Mr GRANT—No amount of air or steam will burn clinker.

The PRESIDENT—You can't burn it. What comes of it?

Mr WADDELL—It must gather in the ashpit. There is a large ashpit.

Mr GRANT said they had simply got to clean out their fires the same as in any other case. Whenever it clinkered up, they had to clear it out. They had to have the bars close, or the fine coal would come through without being consumed. They always wished to have some clinker in the bottom, so that the fine stuff might lie on it. The air and steam went through the clinker.

Mr ROBERTS said at Gilbertfield they fired with gum. They thought this process would help them to raise the steam better. The amount of ashes they had to take out of the fire was so great they also thought if they could get the steam injector to work properly there would be a great deal less labour.

Mr WADDELL—How often did you clean the ashpit?

Mr ROBERTS—Twice a day.

The discussion was adjourned.

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DISCUSSION ON MR LIVINGSTONE'S PAPER ON "A SYSTEM OF WORKING SHALE, SIX FEET THICK, WITH A TENDER ROOF, AT AN INCLINATION OF 30° AND UPWARDS."

The SECRETARY read the following communication from Mr Robert Martin :—

Boring.—This is not so simple a matter as it appears from fig. 1. Unless the surface is light, boring alone is not a reliable guide. The outcrop surface line is sometimes so irregular, folding into forms resembling loops and other shapes. The metals may be covered with ten or twelve fathoms of sand and boulders, and may be quite on end or nearly so. In these circumstances, boring is only bewildering. Fig. 2 does not accurately represent the facts, and is rather misleading. The lower coal measures near the centre, as worked at Niddrie and Loanhead, are very much steeper than the carboniferous shales underlying, and no account is taken of the thinning out of the shales which evidently takes place somewhere in the basin. This is a geological problem which probably only actual mining will solve. No oil shales have been got on the other side, or all the world would have heard of oil works at Newbattle and Arniston. I see no necessity for the diamond bore on fig. 2, at least in the position shown. The coal measures are well known, and so are the shales, &c., down to the Straiton Main, which have nearly all been proved by crosscut mines. The real *terra incog.* begins where the bore seems to stop. I do not agree with Mr Livingstone's estimate of 360 fathoms as the depth of the basin ; it is in my opinion nearer 500 fathoms. The cost of a diamond bore would fit up a winding arrangement and sink a mine in the seam which would give results more reliable than a dozen bores, and be a source of output as well.

Vertical Pit.—Mr Livingstone suggests that a vertical pit should be sunk and the mines discarded, because (1) "the inclines crush and creep all the time." This crushing was, however, entirely due to not removing the ordinary pillars as the works extended down the hill, and so taking the weight off the inclines.

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(2) Because "one shaft is equal to four mines." This is so because of the defective and obsolete system of winding from these inclines as if they were ordinary dooks. I would say on this point that the arrangements—both of winding and pumping—which successfully carry the works to the bottom of the basin should be quite as effective to get the bottom shale. It would look like folly to break up good fittings and go in for a brand new equipment, the cost of which for even a 360 fathom shaft would be no light matter. An incline on a grade of 33°, fitted with powerful enough machinery, and hauling vehicles like railway trucks or Yankee gunboats, such as Mr Moore propounded some years ago, would be equal to any shaft, and leave time for repairs.

Method of Working.—That described will do very well down to about Nos. 5 and 6 levels. It is a mistake, however, to turn all the section into pillars first, and then commence "stooping from the centre." The weight is sure to run over the pillars. If stoop and room is insisted on, the line of stooping should follow the faces as closely as possible. At greater depths stoop and room is almost impracticable, and some form of long wall will be found best adapted to cope with the great roof pressure. The experiment across the hill will be interesting. Mr Livingstone is aware that mines could not very well be worked where he has drawn No. 4 and No. 6, the shale there being almost vertical for about 100 fathoms, and then going comparatively flat, and so on.

Pumping.—I agree with Mr Livingstone that neither steam, taken down in pipes, nor pump rods are at all suitable for deep inclines; but not much progress has been made anywhere in the adoption of newer and better methods.

Shale Cleaning.—Mr Livingstone's remarks on this point deserve the attention of the oil trade. If shale was bought and sold like coal, no doubt mechanical cleaning arrangements would have been introduced before this.

The SECRETARY said, in reading Mr Livingstone's paper, it occurred to him that there appeared to be a mixture of fact and supposition, and that possibly there was not that distinction drawn between what Mr Livingstone had experienced at Pent-

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land, and what he thought might be in certain circumstances. He did not know that Mr Livingstone pretended that this system was applicable in its entirety to that district. It would be well that he should distinguish between what he had experienced and what was merely supposition, because he thought Mr Martin had run away with the idea that Mr Livingstone treated the subject as if all the circumstances existed at Pentland.

Mr R. L. GALLOWAY said he did not think Mr Martin's comments were applicable, because he was discussing what had actually taken place, and Mr Livingstone was considering what might be.

Mr LIVINGSTONE said Mr Martin was formerly at Pentland, and knew all about the place, but what he (Mr Livingstone) was wanting to bring out from the members of the Institute was if the system he proposed was a proper one.

Mr HASTIE, referring to page 110, said Mr Livingstone seemed to think Mr Martin's system of propping was correct, for he was prepared to adopt it.

Mr M'LAREN, referring to page 109, asked Mr Livingstone what means he adopted to prevent the strata from the stoop above coming down on those who were working below.

Mr LIVINGSTONE explained that, when they cut through, their inclination ran about 33° or 34°. Then there was no great tendency to run. That was why he considered slicing preferable to going up the centre. If they went up with slices, although it ran down, all the shale was out, and all they had to do was to go back to the bottom of the stoop and take up another slice.

Mr M'LAREN said Mr Livingstone should remember, if they took out a stoop at the top, where the slope is 34°, and withdrew the timber, the place above fell. Consequently, the *debris* running down hill fell against the stoop below. Well, how would they prevent that material coming down upon the miners in taking out the last portion of the slice? The stoops in some of the steep measures are left at the last break to prevent the material from coming down.

Mr LIVINGSTONE said the shale was not broken. It was not like coal. It did not break immediately after, but was

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tough and strong. In general cases, there were no slips, though sometimes there were, and a portiou of the last breaking of shale was lost.

On the motion of the President, the discussion was adjourned till next meeting.

DISCUSSION ON MR GRANT'S PAPER ON "AN IMPROVED PATENT METALLIC PACKING FOR PISTON RODS AND PUMP PLUNGERS."

The PRESIDENT asked Mr Grant if he had ever tried the packing on a plunger.

Mr GRANT—Not yet, but it was principally for plungers that it was designed.

The PRESIDENT—Would it not be an awkward thing to renew it?

Mr GRANT—That is the awkwardness of the whole business. You would have to disconnect the machinery.

The PRESIDENT—You think it will last the life of a pump?

Mr GRANT—It will last as long as the pump will last.

Mr GALLOWAY—Has it been tried?

Mr GRANT—Yes. The first, which was not perfect, was tried on a winding engine at Fence Colliery, and has been in use since the month of February. It was always leaking a little. There was another on an air-compresser since the month of May, which was perfectly tight, and there were two at Overtown and one at Govan Iron Works on a locomotive since March. There were other six working on an ordinary engine, and were quite tight.

Mr GALLOWAY—None have been tried for a very long time?

Mr GRANT—If it is tight at the beginning, it will be tight always. The one on the winding engine was a little defective, because it was the first. It was merely experimental. It is proposed to put a new one on which it is expected will be perfectly tight.

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The CHAIRMAN said they would require to see that everything fitted perfectly at the first.

Mr GRANT said a piston rod that had been working had a tendency to be grooved, and if very much so it would leak for some time until the rings wore in. The greatest difficulty was to join the top and bottom, and in putting a new packing into an old box. In a new one it was different, because they could grind it into a perfect metallic joint. Mr Grant, in further answer to the President, explained how it was screwed up, and stated that the arrow head in the diagram in last Transactions should have gone down to the black body.

The PRESIDENT said if this was to last the life of a pump or steam engine, the engineman would look on it as a boon. It looked a good thing, but had not had a long chance, and if it proved a good thing everyone would be buying it. He closed the discussion, and on his motion Mr Grant was awarded a vote of thanks.

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SAN FRANCISCO.

THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE

ROOMS OF THE CHRISTIAN INSTITUTE, GLASGOW,

18th December, 1890.

JOHN M. RONALDSON, Esq., President, in the Chair.

THE minutes of the last General Meeting were read by the Secretary, and confirmed.

The following gentlemen, who had been duly nominated, were elected by ballot as ordinary members:—

JOHN SIMMONS, Bardykes Colliery, Newton.
T. E. FORSTER, N. Jesmond, Newcastle-on-Tyne.
R. TILDEN SMITH, 12 and 14 O'Connel Street, Sydney, N.S.W.
ADAM ALEX. BOYD, Newcastle, N.S.W.

The discussion of Mr M'Laren's paper on "Working Thick Coal Seam by Longwall, at Balgonie Colliery, Fife," was closed after a vote of thanks had been awarded to the author.

In the absence of Mr Rowan, the discussion of his paper on "Meldrum's Forced Combustion Furnace" was adjourned.

The following discussion then took place:—

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DISCUSSION OF MR ARCHD. LIVINGSTONE'S PAPER ON "A SYSTEM OF WORKING SHALE 6 FEET THICK WITH A TENDER ROOF, AT AN INCLINATION OF 30° AND UPWARDS."

The following communication from Mr Archd. Livingstone was read by the Secretary :—

Mr Martin says the boring is not so simple as it appears in figure 1, and he gives some reasons, and for these reasons I suggest the diamond bore well forward in the field, as the chisel bore has been proved a failure :—

1st, There was a chisel bore put down for the Pumpherston Shale, and a shale was got, but although a small vertical pit was put down through running sand at considerable expense, the shale was found to be unworkable; and 2nd, in boring for the Broxburn Shale, the chisel was used, and being a little too far back on the surface, went through an inferior shale 15 feet under the Broxburn seam, and the mine was sunk for the inferior shale, with the result that when the inferior shale was reached, the mine had to go at a few degrees less inclination to cross-cut into the Broxburn seam. For these reasons, along with many more I could give, I consider that a diamond bore well forward in the field that would catch all the shales is the more profitable. Of course all the seams are now known, not only as far as Straiton main seam, but as far as Burdiehouse Limestone or Camps Lime in the Pentland field; but this is not the point; the point is—whether in boring, "dabbling" about the outcrops with a chisel or going well forward in the field with a diamond bore is the better method. I submit that the latter is the better system. Mr Martin may be quite correct about the depth of the basin in Pentland, but at page 113 I say, "taking the inclination of the strata at an average of 33 degrees from the outcrop, the depth of the pit would be 360 fathoms at the point shown in Fig. 3," but as to the actual depth of basin referred to by Mr Martin, this is a problem which perhaps only mining will solve.

As to the cost of a diamond bore being sufficient to fit up and sink a mine, before a mine be sunk the shale must first be found, and if it is to be found by boring, is it a chisel or diamond that is to be used in the finding of it? I think this is the point, and this being the point, a diamond bore should be adopted. In connection

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with the vertical pit, I do not suggest that the mines be discarded. It will be found at the bottom of page 109 and top of page 110, that the intention is whenever a connection is made with the vertical pit that the mines go no further down, but that they then begin and take the barriers out of both sides of the inclines up the hill. Nos. 1 and 2 mines would require to be left to protect the statutory second outlet. Of course, whenever the barriers were taken out up to the mine mouth, the mines would then be abandoned. The only thing I would discard whenever there was a connection made, would be the temporary pumping arrangement that was required to drain the workings till the connection was made.

Mr Martin suggests that the arrangement that would carry the dook to the basin would work out the bottom shale. I do not agree with this, as an arrangement would carry the dook down and pump the water, that would not cope with the water after the field was all opened out and in full swing.

Mr Martin suggests for winding purposes, railway trucks, or Yankee gunboats. He has had the tunnel from Queen Street Station to Cowlairs Station in view perhaps, but he is altogether overlooking the tender roof. In my opinion, the smaller the openings the better, as the smaller they are the easier will the roof choke itself and be more easily repaired. In fact, when writing the paper, my idea was single hutch or carriage roads.

There seems to be something in Mr Martin's suggestion that the line of stooping should be as close behind the ordinary faces as possible, and no doubt will be worthy of attention when great depths are reached. Then, as to the great depth and consequently the great pressure necessitating some form of longwall, with this I partially agree, and would not think of working the Fell's or Broxburn seams in any other way than longwall ; but to work the seam described longwall, some of the shale must be left on to protect the miner and keep the working faces from falling, but I am of opinion that the system (subject to modification as circumstances arise) I have endeavoured to describe in my paper is the system whereby, even at great depths, the greatest quantity of shale may be got at the cheapest rate.

The discussion was adjourned.

The following paper on " Notes of Shale Mining at Oakbank " was then read by Mr Alex. Faulds :—

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NOTES OF SHALE MINING AT OAKBANK.

By Alexander Faulds.

Oakbank Pits are situated in the parish of Kirknewton and county of Mid-Lothian, and are owned by the Oakbank Oil Company, Limited.

The seams worked are the M'Lean shale and the Dunnet shale, lying in the calciferous sandstone series ranging from flat to 28 deg. or 1 in 2, averaging about 14 deg. or 1 in 4. The field is large, and the Dunnet shale is not yet so extensively worked as some of the upper seams.

Two shafts are sunk about seven yards apart—the old or pumping shaft, 11ft. by 5ft., 73½ fms. from the surface to the New shale, 7ft. thick; and the new or winding shaft, 18ft. 4in. by 6ft., 64½ fms. from the surface to the Dunnet shale, 6ft. thick.

The pumping in the old shaft is done by a Barclay's Grasshopper engine, 62in. cylinder by 8ft. stroke and 10ft. stroke of plunger, 27¾in. diameter; through discharge pipes, 40 fms. by 24in. dia., top lift; low lift pipes, 36 fms. by 18in. dia.; and plunger, 24in. dia.; 2½ strokes, 523 gallons, or nearly 2½ tons of water per minute.

Daily output about 100 tons M'Lean shale, 300 tons Dunnet shale—in all, 400 tons.

A fan, 18ft. dia. by 6ft. broad, one eared, driven at 54 revolutions per minute by a horizontal engine, 10in. cylinder by 2ft. stroke, ventilates the workings, the old pit being downcast and the new pit upcast.

The system of working the M'Lean shale is longwall, and, being as steep as 28 deg., or 1 in 2, shoots similar to those described in Mr Johnstone's paper on Niddrie workings are adopted instead of roads.

The system of working the Dunnet shale is partly stoop-and-room—stoops from 20 to 30 yards square, rooms 14ft. wide. No stooping has yet been done. This seam is principally worked longwall, similar in mode to that in use at Carfin Colliery (Wm. Dixon's, Limited) in working the Virtuewell coal and Roughband ironstone.

The Dunnet or thick seam is in two leaves. The lower leaf

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which is 3ft. thick and termed the bottom working, is holed in the usual way by the miner, and blasted down for a distance in not exceeding 9ft. from the face of the brushing at the roadhead and 18ft. from each side of the face of the roadside building, the road being 9ft. wide between the buildings, making the walls 15 yards along the shale face. While this area is being taken out by the miner, the roof is supported at regular intervals with props in the roadheads and cundies, and the roadsides are built with old railway sleepers, 9ft. by 10in. by 5in., or old waggon timber cut up into pieces, 4½ft. by 5in. by 5in. or thereby, forming the timber pillars, 4½ft. square, and set from 3ft. to 4ft. apart, the centres of these pillars being well stowed with holings and material from the brushing.

When the shale is all taken out of this the props are drawn, those at the roadhead last, and the whole section to the top of the upper leaf is dropped.

The upper leaf or top working of the shale is then taken out and the roadsides on the top of the brushing built with old railway sleepers, or old waggon timber cut up into pieces 3ft. by 5in. by 5in. or thereby, again forming timber pillars 3ft. square, also from 3ft. to 4ft. apart, being similarly stowed to those in the lower leaf or bottom working.

After the upper leaf or top working is completed, and before the timber pillaring is finished, the calmy blaes, 3ft. 5in. thick, is brushed and stowed in the centre of and between the pillars. Until such is done, part of the roof of the top working is supported on props and occasionally on a few timber pillars, the props being drawn as the pillars are completed. The same operations again begin in the bottom working as already described.

The walls, as has been stated, are 15 yards long, and the roof being tender the best results are generally got by keeping each wall a break in advance of the other, and as far as practicable avoiding two walls next each other being dropped at the same time. The maximum length dropped at any time with such roof should not exceed 15 yards by 3 yards.

The lower leaf is the inferior shale, and the portions named Curly and Pugs, where good, are also put out. The bottom working is generally taken out first. The bottom shale

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frequently varies in quality, and in thickness from 1ft. to 6ft. The pick holing also frequently disappears to a "pricking" only, causing a powder holing, which is of course more expensive to work.

Section of Pit, ... *No.* ..... *Level,* .....

Description of Places as found on *18*

No. of Place.	Miner's Name.	Working in		Width of Place in feet.	Thickness in Feet of		Holing with		Timber Pillars.		Remarks.
		Bottom	Top.		Shale	Holing.	Pick.	Powder.	From face of Shale in feet.	Width betw'n a cross road in feet.	

The brushing varies from 3ft. to 6ft. thick. Wants and basins are occasionally met with in both the lower and upper leaves. These frequent variations necessitate the bottom working of each wall being inspected at least twice a week and carefully noted as here shown.

This also forms a check against foreign material being put out with the shale.

The upper leaf is the superior shale, or seam proper, and requires to be kept free of blue stone and mid stone, or brushing, as well as grey stone. It is generally very tough to work out.

Choke damp and white damp are occasionally met with, and fire-damp very seldom, unless when the walls exceed the maximum area, or a large break takes place in the roof.

Great care is necessary to keep the ventilation properly distributed, there being great tendency to leakages through these timber pillars and breaks in the roof.

Continuous blasting is carried on, and the charges in the blasting being heavy the comsumption of gunpowder is very great.

The hutches or tubs carry 10 cwt. of shale, with 10in. flanged wheels under the box of the hutch or tub on a gauge of 23in. laid with common

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malleable iron bridge rails, 14 to 16 lbs. per lineal yard; with no platforms, substituting instead a cast-iron plate, 4ft. by 21ins. inside gauge.

The drawing is done from the faces by drawers employed by the miners, and from branch roads (40 to 50 fathoms long, driven direct to the rise) with cuddies and cuddy wheels to the levels, then along the levels to the cousies, and cousies and levels to endless chains travelling at about 75 ft. per minute, to the pit bottom; thence to the surface with cages having two hutches or tubs side by side on each cage; from the cages to self-acting tumblers, tipping shale from hutch or tub into waggons, which are trimmed and taken direct by a locomotive to the breaker or crusher, the breaker delivering shale into bogies, and then hauling it to the retorts or bin with endless chain arrangement.

The mode of working the Dunnet seam looks rather dangerous, and although a daily average of men and boys of 250 were employed, still the accidents for the year ending March, 1889, were—fatal, none; and non-fatal as under:—

In M'Lean Seam.

Miners.	Drawers.	Enginemen.	Days off Work.	From Sides.	From Pavement.	From Roof.	Remarks.
1	...	...	1	Holing	...	...	At faces.
1	...	...	18	...	...	Blaes	
1	...	...	1	...	...	Blaes	
...	1	...	5	...	...	Blaes	On roads.
3	1	...	25	...	..	..	Total injured, 4.

In Dunnet Seam.

1	...	...	40	...	...	Brushing	Working in bottoms.
1	...	...	7	...	...	Curly	
1	...	...	57	...	...	Curly	
1	...	...	60	...	Pugs	...	
1	...	...	1	...	...	Greystone	Working in tops.
...	1	...	2	...	...	...	With hutches on roads.
...	...	1	2	...	...	...	
...	1	...	5	...	...	...	
...	...	1	1	...	...	...	
5	2	2	175	...	...	...	Total injured, 9.

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The branch roads seldom exceed 50 fathoms in length, when they are cut off by either levels, slope roads, or cousies, whichever is most suitable, and where the seam is steep (28 deg. or 1 in 2) the roads are driven level off a slope with the wall breadth to the rise, excepting as much on the low side of the road as will allow for pillaring.

The timbering and second brushing of the main roads require to be frequently done with crowns of 5 in. foreign propwood and larch 10 ft. by 10 in. by 5 in., on account of the rapid subsidence of such a working.

The timber used per ton of shale raised was—lineal feet of 3 in. foreign propwood, 1·00; lineal feet of 5 in. foreign propwood, 0·33; old railway sleepers, 9 ft. by 10 in. by 5 in., 0·50; and the cost for timber, 2·30d per ton of 20 cwts.

The extra cost for deficiencies in working the lower leaf or bottom shale was 0·50d per ton of 20 cwts.

The working places were wrought with two miners and one drawer in each, using 3 lbs. gunpowder daily, and putting out 5·37 tons daily on an average, or a daily darg of 1·79 tons per man.

Before the new shaft was sunk and the railway made, the shale was hauled by endless chain out of a mine or ingoing eye by an ingenious mechanical arrangement made by Messrs Grant & Ritchie, Kilmarnock, as shown on Plate III., and is simply an eight-grooved drum, 4ft. dia., set level, and a seven-grooved drum, 2ft. dia., set at such an angle so that the first groove of small drum is exactly in line with the second groove of the large drum, and so on for reefing the chain, the idea being to prevent one coil of chain from rubbing against the other, and also preventing the chain from becoming crystallised and breaking.

The completion of section of Oakbank old shaft is due very much to Mr Robert Thomas Moore, C.E., who gave the desired information very willingly.

The following are approximate sections of—

WEE SHALE, OR No. 1, ... 1ft. 6in. thick.

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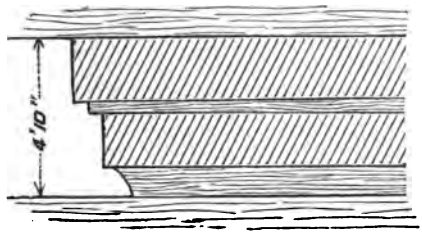
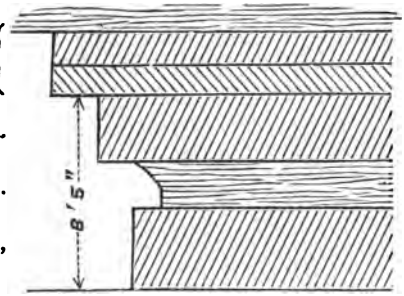
BIG SHALE, or No. 2.



		Ft. In.	Ft. In.
Roof, ...	Shale.		
Seam, ...	Shale,	2 5	2 5
	Daugh,	0 1	
	Shale,	1 8	1 8
Holing, ...	Daugh,	0 8	
Pavement,			
Height of Working, ...		4 10	
Thickness of Shale, ...			4 1

WILD SHALE, or No. 2a, ... 6ft. 0in. thick.

CURLY SHALE, or No. 3.



		Ft. In.	Ft. In.
	Shaley Blaes.		
Roof, ...	Shale,	0 9	
	Curly,	0 6	
Top Seam, ...	Shale,	2 3	2 3
Holing, ...	Blaes,	1 8	
Bottom Seam,	Shale,	2 6	2 6
Pavement, ...	Blaes,		
Height of Working, ...		6 5	
Thickness of Shale, ...			4 9

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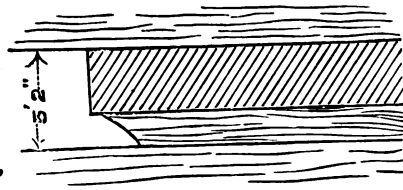
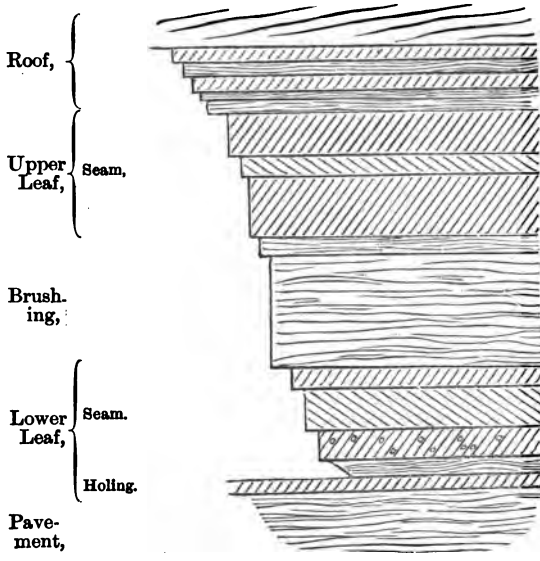
M'LEAN SHALE, OR No. 4.



	Ft.	In.	Ft.	In.
Shale (good),	3	4	3	4
Soft Calmy Blaes,	1	10		
Height of Working,	5	2		
Thickness of Shale,			3	4

TWO FEET SHALE, OR No. 4A, ... 2ft. 0in. thick.

DUNNET SHALE, OR No. 5.



	Ft.	In.	Ft.	In.	Ft.	In.
Calmy Fakes.						
Coarse Shale,	0	6				
Kingly Rib,	0	4				
Curly Shale,	0	5				
Kingly Rib,	0	1½				
Grey Stone,	0	5				
Shale (good),	1	2				
Do. (tough),	0	4			3	0
Do. (good),	1	6				
Blue Stone,	0	4				
Calmy Blaes,	3	5				
Curly Shale,	0	5				
Brown Ribbed Shale,	1	6			2	9
Bally Shale,	0	10				
Calmy Blaes,	0	6				
Shale (Pugs),	0	3	0	3	3	0
Grey Fakes.						
Height of Working,	10	3				
Thickness of Shale,					6	0

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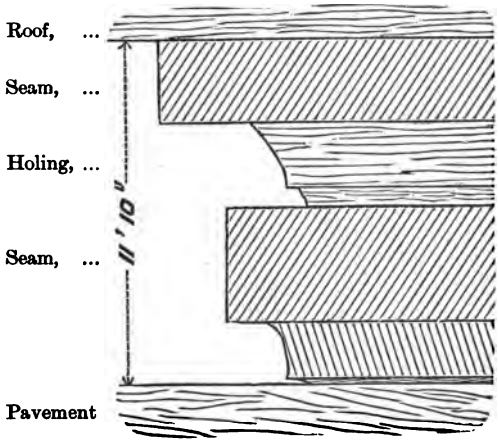
NEW SHALE, ... 7ft. 0in. thick.

DUNNET SEAM AT NEWLISTON, NEAR BROXBURN.



		Ft.	In.	Ft.	In.
Shale,	...	3	0	3	0
Shaley Blaes,		2	0		
Calmy do.,		0	4		
Shale,	...	4	0	4	0
Shale,	...	2	6	2	6
Pricking.					
Fakey Fireclay.					
Height of Working,	... ...	11	10		
Thickness of Shale,	... ...			9	6

This seam is worked by a mine or ingoing eye from the surface, stoop and room. Stoops near the surface 40ft. square, and to the dip 60ft. square ; rooms, 12ft. wide.

CALIFORNIA STATE
Mining Bureau,
SAN FRANCISCO.

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Comparison of Shale Seams.

Name of Seam.	No.	In Feet.		Holing.	Mode of Working.	Yield in Gallons of Crude Oil per Ton of Shale.	Remarks.
		Height of Working.	Thickness of Shale.				
Wee, . .	1	...	1·50	...	...	...	Oakbank
Big, . .	2	4·58	4·08	Bottom	Longwall	About 32	
Wild, . .	2A	..	6·00	...	...	...	
Curly, . .	3	6·41	4·75	Mid	Do.	,, 30	
M'Lean, .	4	5·16	3·33	Bottom	Do.	,, 35	
Two Feet, .	4A	...	2·00	...	Do.	,, 35	
Dunnet, .	5	10·25	6·00	,,	...	...	
New, . .	6	...	7·00	...	...	...	
Dunnet, .	5	11·83	9·50	Mid	Stoop and Room	32 to 45	Newliston

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Section of Oakbank Old Shaft.

No. of Seam.	Strata. Description.	Thickness.	Depth from Surface.
		Ft. In.	Fms. Ft. In.
	Surface and various Strata,	40 0	
1	Wee Shale.	1 6	6 5 6
	Various Strata, ...	13 0	
2	Big Shale, ...	4 6	9 5 0
	Various Strata, ...	12 0	
2A	Wild Shale, ...	6 0	12 5 0
	Various Strata, ...	10 0	
3	Curly Shale, ...	6 0	15 3 0
	Various Strata, ...	5 0	
4	M'Lean Shale, ...	4 0	17 0 0
	Various Strata, ...	16 0	
4A	Two Feet Shale, ...	2 0	20 0 0
	Various Strata, ...	261 0	
5	Dunnet Shale, ...	6 0	64 3 0
	Various Strata, ...	45 0	
6	New Shale, ...	7 0	73 1 0
	Various Strata, ...	8 0	74 3 0
		447 0	
	Bottom of Shaft, ...	74fm. 3ft. 0in.	

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General Section of Broxburn District.

Strata.

Description.	Thickness in Fms.	Approximate Depth from Hurlet Limestone In Fms.
Position of Hurlet Limestone,		
Various Strata, ...	25	25
B. B. Ironstone,		
Various Strata, ...	43	68
Raeburn Shale,		
Various Strata, ...	32	100
Mungal's Shale,		
Various Strata, ...	28	128
Grey Shale,		
Two Feet Coal,		
Houston Marl, ...	30	158
Grey Shale,		
Various Strata, ...	10	168
Houston Coal,		
Fakey Sandstone, ...	35—45, say 40	208
Fell's Shale,		
Broxburn Marl, ...	45	253
Broxburn Shale,		
Blaes and Thin Shale, ...		
Binney Sandstone, ...	70—80. say 75	328
Blaes and Limy Ribs, ...		
Dunnet Shale, ...		
Blaes and Limy Ribs, ...		
Fakes, &c., ...	60—70, say 65	393
Barracks Shale, ...		
Burdie House or Camps Limestone, ...		
Chiefly Blaes, ...	130—140, say 135	528
Pumpherston Shales,		
Total Depth, ...	528	528

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THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE ROOMS OF THE

ROYAL SCOTTISH SOCIETY OF ARTS, EDINBURGH,

31st January, 1891.

JOHN M. RONALDSON, Esq., President, in the Chair.

THE minutes of the last General Meeting were read by the Secretary, and confirmed.

The following gentlemen, who had been duly nominated, were elected by ballot as ordinary members:—

JOHN BLOCKLEY JAQUET, 8 Alwyne Square, London.
ERSKINE RAMSAY, Pratt Mines, Birmingham, Alabama, U.S.A.

The following discussions then took place:—

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DISCUSSION OF MR FRED. J. ROWAN'S PAPER ON "MELDRUM'S FORCED COMBUSTION FURNACE."

Mr FAULDS said he expected Mr Roberts, Gilbertfield Colliery, Cambuslang, to have been present. The furnace was in operation there, and had been very unsuccessful. They were adopting some slight alterations which Mr Roberts would have explained had he been present, and which might probably cause it to have some better effect.

The SECRETARY read the following communication from Mr Rowan:—"I regret that absence from home and illness have combined to prevent my attendance at the preceding meetings of the Institute, and my replying sooner to the discussion which took place on the 20th November last. I find some difficulty in replying to the discussion as reported, because the report does not make it very clear whether Mr Grant and Mr Robert Waddell referred to the same or to different arrangements of apparatus. I take it, however, that Mr Waddell and Mr Roberts spoke about a trial of a steam blast applied to the ashpit of one boiler, and Mr Grant spoke of the application of an air blast to the ashpit of another.

The two questions put by the President refer to details that are fundamental to the understanding of the subject. With reference to the first question, the President was evidently under a misapprehension, because both steam and air are admitted below the fire bars, as I mentioned at page 79 of Transactions, Vol. xii. Part 4. Were steam alone admitted, the fire would in a short time be extinguished on account of the absorption of heat by the chemical actions produced. The blowers of Messrs Meldrum are so proportioned that the jet of steam of a given pressure forces in, or induces, *i.e.* leads in, the requisite proportion of air for combustion along with it, and the steam, under such circumstances aids the actions proceeding and preserves the fire bars by the lowering of temperature which accompanies its decomposition. Too much steam, even along with air, would cause loss of heat, and thus loss of duty from the fuel burned. The refuse—ash and clinker—referred to in the President's second question, is periodically removed through the door provided for this purpose

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in the ashpit casing. The steam greatly aids in the work of removing clinker from the bars, and thus materially shortens the work of cleaning fires. Moreover, the system of working—approaching as it does to gas-firing—permits of the accumulation of a considerable layer of ash on the bars without sensibly lowering the efficiency of the furnace, and thus the cleaning of the fires need not be so frequent as in ordinary hand-stoking, or even with mechanical stokers which have not moveable bars.

The apparatus mentioned by Mr Waddell and Mr Roberts seems to have some features in common with the one described by me, but the difficulties which they have evidently experienced in working it illustrate the value of having all the practical details, such as proportionate sizes of parts, dimensions of openings, &c., worked out. A much greater amount of money is frequently spent in experiments than what is represented by the cost of an apparatus, the practical details of which have been worked out in actual trials. Thus, although in this case it would no doubt cost less to put a steam pipe through a hole in an ashpit front, than is asked for Messrs Meldrum's complete apparatus, yet the mere cost of materials and construction of an apparatus that seems to be similar by no means embraces all the elements essential to successful working. I have not claimed novelty for the idea represented by Messrs Meldrum's apparatus, but have put before the Institute a carefully worked out plan for successfully utilizing their coal dust and inferior dross as fuel for steam boilers. If Mr Roberts will communicate with me I shall be glad to assist him in removing his difficulties.

In Mr Grant's case the cost of an engine has to be considered, besides that of a fan before the combustion furnace itself is dealt with. Engines do not, unfortunately, "happen" to be present always where they are wanted, and in such cases must be bought. If the coal dust he mentions was damp and did not contain much dirt, then the air blast applied as described by him would no doubt act efficiently. But in cases where it might be attempted to burn dry dust in that way, or dust containing a large percentage of dirt, loss would be occasioned by the dust being to some extent blown into the flues or up the chimney, and by the fire-bars being destroyed by an

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excessive temperature in presence of cinder. I have again to thank the members of the Institute for the courtesy with which they have received communications from me."

The PRESIDENT thought Mr Roberts, according to the statement made by Mr Faulds, was in great need of Mr Rowan's assistance, and that the best thing would be to bring the two together and see what they could make of it. With reference to what Mr Rowan mentioned with regard to the question that he (the President) put, he was not clear whether air was admitted along with the steam below the furnace bars. Of course, they all understood that air must get in for the purposes of combustion, but Mr Rowan's paper did not make out clearly whether air was admitted along with steam below the furnace bars. They would agree that this was an important subject. He noticed with regard to marine boilers a great deal was being done by forced draught, and apparently marine engineers seemed to think a great deal of it. There was no reason, if it was useful with regard to marine boilers, why it should not equally apply to land boilers. He proposed that they accord Mr Rowan a vote of thanks for his kindness in bringing the subject before them.

This was agreed to.

NOTE.—Since the above discussion took place, Messrs Meldrum and Mr Rowan have stated that it was not Meldrum's furnace that was fitted up at Gilbertfield Colliery. Mr Roberts, the manager of Gilbertfield Colliery, on being asked, confirms this; and Mr Faulds, who was under the impression that the furnace there was Meldrum's, finds that he has been mistaken, and regrets the misunderstanding. JAMES BARROWMAN Secy.

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DISCUSSION OF MR ARCHIBALD LIVINGSTONE'S PAPER ON "A SYSTEM OF WORKING SHALE, 6 FT. THICK, WITH A TENDER ROOF, AT AN INCLINATION OF 30° AND UPWARDS."

Mr HUGH JOHNSTONE said there was some difficulty in discussing this paper—a difficulty to which the Secretary had alluded in an earlier part of the discussion, arising from the fact that the paper was a mixture of fact and hypothesis. It was not very easy for an outsider to separate the two, and consequently the discussion became difficult. He thought Mr Livingstone deserved credit for great moral courage in taking up such a wide subject. So far as he was aware there was absolutely no experience to guide him in the working of a shale of this nature at the maximum depth contemplated in his paper. Therefore, any one taking up the subject was necessarily taking a "leap in the dark." Unfortunately, any one attempting to discuss the paper, must follow Mr Livingstone by making a similar leap. There were one or two points in the paper on which he would like some additional information. Working the shale down from the out-crop, leaving a barrier of 30 fathoms in order to keep up the surface and the surface water, as the inclination which Mr Livingstone assumed was 33 degrees, the cover at a depth of 30 fathoms measured on the slope would be 16½ fathoms. The stooping out of a 6ft. seam at that depth would, the speaker thought, break the surface just about as much as if no barrier had been left in at all. Then, again, one of the leading features of his design was to sink inclines separated from each other by a distance of 300 fathoms. Solid pillars were left on each side of each incline in order to protect it from the roof weight, and they increased in a regular proportion which he gave at p. 109. Now, if they followed out this to his maximum depth he feared Mr Livingstone had placed himself in a difficulty which he would have to overcome. Taking the dip at 33 degrees, the total distance from the outcrop to the shaft was 660 fathoms. He proposed to leave 100 fathoms as the shaft pillars, and the 30 fathoms at the outcrop, making 130 fathoms. That made 550 to be worked out in lifts of 40 fathoms, or, in other words, 13

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lifts of 40 fathoms to be worked out by stoop and room. If they increased the incline pillar which was left in to protect the incline, in the proportion Mr Livingstone set forth, they would find when they got down to the top of the shaft pillar, the whole shale to be stooped out between the inclines was a distance of 40 fathoms. Of course, the distance of 300 fathoms was not perhaps a hard and fast limit, but if the distance was increased, the lift of the roads between the inclines was also necessarily increased; and Mr Livingstone had alluded in strong terms to the difficulty of keeping open roads in these incline workings. Then, further, the stoops themselves increased in size towards the dip, and at the maximum depth 100 fathoms from the shaft the stoops would measure 170 feet in the length, measuring parallel with the inclination of the seam. Now, he should like him to explain how he proposed to stoop this lying at a dip of 33 degrees. There was a practical difficulty that he was afraid it would be difficult to overcome. Of course, he understood from what Mr Livingstone said at pp. 109, 110 and 129, that whenever the mines became connected with the pit they were not sunk further down, and that, from that point, the shale was removed and drawn towards the pit, while the incline pillars formerly left in were taken out backwards towards the inclines. Mr Livingstone spoke of the expense of maintaining these inclines, an expense which those who had had to do with them would agree it was scarcely possible to over estimate. Mr Martin seemed still to have a lingering fondness for an incline, but, if that was so, he took it that his case was simply an exception which proved the rule that the more one knew of these inclines the less one liked them. He would like to suggest for Mr Livingstone's consideration the reversing of his process. Instead of working from the outcrop downwards, he should take it from the pit upwards. Take out the lower part first, and then the upper part either by working down from the crop, or by cross-cutting from the shaft. By this means he would overcome a great deal of the difficulty in the matter of water, as experience told them in shale workings, until the roof was broken towards the crop, there was rarely much water to be dealt with. It was possible the lower part of the basin would be worked dry.

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At the upper part the water could gravitate towards the waste, and it would only be necessary to pump the water from the level where the lowest workings were. He inclined to agree with him that, when the maximum depth was reached, it would be altogether impracticable to work such a seam as this by any ordinary method of stoop and room working. If the inclination could be supposed to remain continuous at 33 degrees it might be possible, but should it increase, the difficulty and expense of working by such a system would increase at an enormous ratio, and he thought the solving of the problem would be found in some method of long-wall working, not to the rise, but across the hill, possibly with narrow roads through the solid, and working back, leaving the waste behind. Of course part of what he had said did not necessarily come out of that paper, but he should like those who had had large experience in working shale at high inclinations to give their ideas on working in the method he had described.

Mr LIVINGSTONE indicated that he did not wish to go further in the matter at present.

On the motion of the PRESIDENT, the discussion was closed, and Mr Livingstone accorded a hearty vote of thanks.

DISCUSSION OF MR ALEXANDER FAULDS'S PAPER ON "NOTES OF SHALE MINING AT OAKBANK."

Mr J. B. ATKINSON said he noticed that Mr Faulds mentioned white damp. He should like if he would tell them what effect this gas had upon lamps and men. He saw also the term "shale" generally applied. He supposed in all cases oil shale was meant.

Mr FAULDS answered in the affirmative.

The PRESIDENT said he thought it was generally understood, when shale was spoken of, oil shale was meant. Mr Atkinson was quite right to draw attention to the matter.

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Mr ATKINSON said any one out of the district might not understand this.

Mr FAULDS said the white damp that was found in the shale was also found in the coal mines of Fife. It created a flame not unlike air mixed with choke damp, but very much brighter.

Mr BEITH asked if white damp did not draw the flame more than the choke damp.

Mr FAULDS—Yes, slightly. Some of the Fife gentlemen would be able to explain the matter from their experience of it.

Mr JOHNSTONE asked if the white damp they had in Fife was not invariably a product of combustion; and, if so, was there not combustion to account for the presence of the gas?

Mr LIVINGSTONE, speaking of another point in the paper, said Mr Faulds stated that there was no stooping done in the Dunnet seam. Could he say what area would be standing in stoops and at what inclination?

Mr FAULDS said, speaking from memory, he thought about a tenth part of the area was in stoops, and it was at the same inclination as he had mentioned in the paper. The area would, he presumed, be about ten acres, and whether it was due to being a worse method of working the field than long-wall he could not say, but it was worked stoop and room to that extent.

Mr J. B. SNEDDON said he might supplement Mr Faulds's remarks as to the Dunnet stoop and room workings. The idea was to prevent the water from coming down from the level above to the lower workings. That was the meaning of its being worked stoop and room.

The PRESIDENT said there was one question he would like to ask, viz., with reference to the working out of the upper ply of the shale described at p. 131. Was it not found in experience that the dropping of such a large area of the upper shale at once allowed the roof to fall sometimes?

Mr FAULDS said when they took out the props of the bottom working and dropped the midstone along with the upper shale, the roof seldom came down unless several faces were dropped together through irregularity of working. He had been asked to express what effect white damp had on the men. White damp

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had this disadvantage compared with choke damp, that it fed the flame of the lamp and kept a good light, deceiving the men, while at the same time it had the same effect on the men as choke damp.

The PRESIDENT—Is it not worse ?

Mr FAULDS—Well, it may be in some cases.

Mr JOHN DURIE said as to this white damp he did not know what it was. He had often heard miners speak of it, but he never could discover what it was.

Mr H. M. CADELL said they could detect sulphuretted hydrogen by its smell of rotten eggs. Carbonic oxide was not distinguished in this way ; but they were both active poisons, sufficient to poison a man, even if present in very small quantity in the air. They both supported combustion, but carbonic acid or choke damp simply extinguished life, because it took the place of the life-supporting oxygen, not because it was an active poison. He must say he would like very much to know what white damp was. He knew the principal gases, but he never could find out what it was, unless it was a mixture of different kinds of gas.

Mr ATKINSON said he did not think carbonic oxide was a natural product in mines. It was not black damp. He should think very likely the white damp Mr Faulds spoke of might be due to the use of large quantities of gunpowder. If there was not plenty of ventilation, the gases from the combustion of gunpowder might accumulate and form the white damp mentioned by Mr Faulds.

Mr FAULDS said in the working referred to it was almost impossible to have been spontaneous combustion which created white damp. He agreed with Mr Atkinson. Here the extent of blasting was very great, and he believed it was by that entirely the white damp was produced in the shale.

Mr THOMSON said one case had come under his notice. They had no black damp at all. The ventilation was going on pretty near to the face of a mine where two men were working. They fired three shots with gunpowder, and went back too soon amongst the smoke and were overcome. He found afterwards that two of the holes had "gunned," and they put the occurrence down to white damp. They got one of the men out, and he was

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nearly overcome himself. He felt quite giddy, and the smell was just as one of the gentlemen mentioned—the same as if they had broken up a bad egg.

Mr ARNOTT said it was supposed to be white damp (carbonic oxide) that was the cause of Mr Drinnan's death at Dalzell Colliery, and its presence was accounted for from the fact of the seam of coal being on fire, the carbon of which must have been incompletely oxidised. The same gas was suspected to have been the cause of an accident at the Carlingcroft Pit, Gartsherrie, about eight years ago, when four men lost their lives. It was assumed that the gas had escaped from the furnace tubes, which passed quite close to the pit. After being down the pit, and especially on returning to the surface, he felt drowsy and quite feeble, with a sense of nausea and giddiness.

Mr ROBT. BEITH said seeing there were a few gentlemen there who had expressed themselves that they did not really understand white damp, they need not be surprised that in the working of the mines they had miners that did not do so. In working amongst choke damp they understood, when their lamps would not burn, that it was time to retire. In white damp also there were some miners who, by noticing their lamps and feeling the smell, likewise knew to retire. Others did not know, with the consequences stated.

Mr DURIE said his remarks were directed to what he considered Mr Faulds mentioned as a fact in his paper. He thought he was referring to white damp as a natural product, not as an artificial product. He had never seen white damp produced naturally, although he had heard of it. It was quite easy to understand carbonic oxide or sulphuretted hydrogen created by imperfect combustion. As had been stated, it was not long since a prominent member of the Institute lost his life by this gas due to incomplete combustion.

Mr FAULDS said he was sorry there were not a greater number of the shale men there that day; otherwise they might have had a good discussion on the paper, and elicited some valuable information.

Mr LIVINGSTONE, referring to p. 138, the results coming from the different shales, asked if Mr Faulds would inform them if

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it was by shale inspection underground or crow picking on the hill he got these results.

Mr FAULDS said the yields were arrived at from verbal information, and they were used only as an approximate comparison. He, however, received the information from those who ought to know. They had crow-picking on the hill, but this was the yield of shale at the oil works. It had nothing to do with crow-picking at all.

Mr LIVINGSTONE said if they got diluted shales they would not get so good results, and he wanted to know if the clean shale was obtained by shale inspection underground or crow-picking on the hill.

Mr FAULDS said there was no inspection beyond the manager, who made periodical visits to the pit the same as colliery managers did. In addition, there was crow-picking, and crow-picking was of no use unless there was inspection of the crow-picking. They had no inspector the same as at Pentland and similar mines. The lower leaf of the Dunnet shale was a shale that fluctuated very much, and he had given a sample leaf of a book which was for the purpose, after an inspection, of noting down the cleanness of the shale. In that manner there was a check kept on workmen who put out dirty shale, the same as in a coal mine. He believed a greater yield would be obtained if they introduced picking tables the same as at a colliery. If they wanted to get clean coal, they must have a cleaning arrangement; and, if they wished to please their customers with good oil, they must have a cleaning arrangement also. If they sent up shale mixed with a lot of dirt amongst it, it gave less yield. The yield in the paper was very nearly the average, and it included 10 per cent. at least of dirt in the shale.

Mr H. M. CADELL said there was one other remark he would like to make. When he was in the Geological Survey, he made a map of the shale fields, copies of which were supplied to various managers. He saw a section in the paper which he recognised as a section which he once constructed when mapping the Broxburn district. A number of depths given were only approximate. He had a good deal of trouble in working out the section for the obvious reason that the thickness of the strata in different parts

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was very variable. The distance between the Dunnet shale and Burdiehouse limestone was hypothetical. It was stated in the section as 65 fathoms; but that was a very rough estimate, because the limestone had never been found in some parts of the area where it was to be expected, and consequently the exact position could not be determined. There had been many bores made over the eastern portion of Linlithgowshire and round about Broxburn, where the limestone ought to have been passed through, and he had come to the conclusion it never was formed there. There was one place where he thought a bore should be put down, from a geological point of view—and, of course, in the case of shale fields, geology was of advantage, to enable them to understand their position—he referred to the bottom of the pit at Oakbank. The Oakbank shale was in an isolated basin cut off from the other shale fields. The limestone occurred in separate basins, and the connection between the shale and the limestone, as exposed at its outcrop, was not very obvious. The only way to ascertain it was to put a bore down at the bottom of the pit. He took it that the limestone ought to be found at from 60 to 70 fathoms; so, if the Oakbank Coy. had a good dividend, for the sake of science, and for their own benefit too, they might put down the bore, and, while proving the position of the limestone, find other shales. He thought it would be a good thing to put down a bore to try to get down to the limestone.

Mr FAULDS said he quite agreed with Mr Caddell regarding the bore in the bottom of the pit or basin. This was not quite in the centre, but he might gain some sections by going lower. It had been contemplated before, and it would complete a very good section if it were put down. It was a basin by itself, and there had been great discussions as to the Dunnet shale at Oakbank, but he thought as placed in the paper they would find it was very nearly correct.

Mr THOMSON said at p. 134 Mr Faulds said where the inclination increased to 28 degrees—about 1 in 2—branch roads were taken off the slope road and run level. What means did they take to run the hutches down these slope roads? Did they use cut chains, or simply followed the old principle of "cuddy" chains;

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Mr FAULDS said the slope roads were in such a position that they managed with a snibble in the hutches, and in some cases with cuddies.

Mr THOMSON asked if it would not be better to run the same roads to the hill and work with cut chains, which were a very good principle.

Mr FAULDS said cut chains were a good principle where a great area was to be worked, but it was not very great in the shale mines where they worked to an inclination of 1 in 2. They sometimes did not use roads. They used shoots similar to what Mr Johnstone described in the Niddrie workings.

Mr THOMSON asked if the shale did not get mixed with rubbish in coming down the shoots.

Mr FAULDS—Of course it does unless they keep the shoots clean.

Mr JOHN LOVE, referring to what Mr Faulds had said in reply to Mr Livingstone in regard to putting on a table to pick the shale, said he would like to hear Mr Faulds further on the subject, because shale and blaes were not so easily noticed as coal and dirt. Without a great deal of training and experience he did not see a picking table would be of much use.

Mr FAULDS admitted that it was very difficult to get a proper crow picker for shale. There was so much likeness between the different stones it required an experienced hand to pick it, but he did not think they could crow pick it so clean as they could do on a picking table. They must have an experienced man for the work, a stranger would not do. At the same time, a percentage of the dirt that came up with the shale contained a considerable amount of oil. In some cases they used some of it, and in some parts it was rather better than others. That immediately on the top of the bottom leaf and the pugs were sometimes put out and sometimes not. They were not put out where the seam was troubled. It would be cleaner if there was a picking table in charge of experienced miners.

The discussion was adjourned.

The following paper by Mr Thomas Arnott on a "Diamond Bore put down at Newton Colliery," was then read by the Secretary :—

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NOTES ON A DIAMOND BORE PUT DOWN AT NEWTON COLLIERY, LANARKSHIRE, 1889-90.

By Thomas Arnott.

The boring plant which belonged to Messrs Thomson Brothers, Dunfermline, consisted of a pair of engines having 6in. by 10in. cylinders, with link reversing motion, turned fly-wheel for belt, barrel geared to work either double or single power or to run free, and having a brake to lower the rods as desired, a 3in. by 6in. force pump connected to the crank shaft, with 1½in. 5-ply rubber hose for carrying water to the vertical or driving bar, portable vertical which is run out of the way when drawing or lowering the boring rods, multitubular boiler, fed by a Gresham injector, "Crown" and core tubes of mild steel, and boring rods; the whole being supplied by A. Bennett & Son, engineers, Dunfermline.

The engines, boiler, barrel, and force pump are mounted upon a wrought iron frame, having broad wheels and powerful brake for road transit, the whole weighing about 5 tons.

The machinery and plant were sent per rail to the Colliery, and removed easily to the site of the bore by the aid of a pair of horses, although the ground passed over was somewhat soft.

Sixteen gallons of water per minute were required to keep the bore clear, and this was led in 2in. malleable iron pipes a distance of about 500 yards, from a supply near one of the pits. The difference of level between the point where water was got and the pump at the bore was about 40 feet.

The boiler is made to stand a maximum pressure of 70lbs. per square inch, and the working pressure varies from 50 to 60lbs. per square inch.

The boring rods, of mild steel, are 1⅝in. dia. outside, hollow in the centre, 12ft. long, and weigh each about 50lbs. including one coupling.

A steel vertical or driving bar, 15ft. long by 2in. outside dia., having a groove along the outside, is used at the top of the rods and connected to the vertical by a slip key which enables it to pass freely through as the bore deepens, while it and the rods are revolved by the vertical. See Plate IV.

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A triangle 38ft. high is necessary for raising and lowering the rods.

Weights (see Plate IV.) are placed on the top of the driving-bar to give a working pressure on the diamonds of from 15 to 20 cwts. when cutting soft strata or coarse sandstone, and from 20 to 30 cwts. when cutting hard and close grained rocks. These weights are taken gradually off again as the depth of bore increases, the rods alone giving the necessary pressure, and when they become too heavy a back-balance weight is used.

At the foot of the boring rods there is a cup 3ft. long and 4½in. inside diameter, by which any balls or sediment too heavy for the water to carry away are caught. This cup and the rods are attached by 2 plugs to a core tube 12ft. long; at its lower end there is a nipple for connecting it and the diamond "crown" together. See Plate V.

The outside diameter of the crown, where the diamonds are set, is $5\frac{3}{16}$ins., and 16 to 18 stones of about 65 carats are set in each. In setting the diamonds a hole is bored as near their shape and size as possible, a bedding of lead is put in, and the steel is caulked or set up all around them.

At the junction of the two plugs previously mentioned there is a loose steel ring, inside of which they revolve, thus preventing the core tube getting worn by rubbing on the sides of the bore hole; and at the same time the friction to be overcome by the engine is greatly reduced. The space between the core tube and the bore hole is only $\frac{1}{16}$in. all round.

Inside of the crown piece there is a spring trap for extracting the cores. Its sides are parallel throughout its inside dia., but bevelled on the outside to allow of its rising or falling when required. When the bore is running the spring trap is up, which enables the core tube to revolve freely, and when a core is being drawn the trap is jammed close down to permit of its being broken off if found necessary.

Hitherto the cutting material has been spoken of as diamond, but it is not so in the gem sense of the word. When diamond boring was first introduced a material called carbonite or carbon diamond, which is got in Brazil was and is still to some extent used, but since the discovery of the diamond fields in South

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Africa what is termed diamond "Boart," or fractured diamonds, from Kimberley are principally used. The cost of the latter at present is about 12s a carat.

No real idea of the durability of the stones can be given, as many of them break or rub away in a few days, attributable to hard, brittle, cuttery rocks, while again there are stones that have been in daily use for over two years and the wear or abrasion of them is almost imperceptible, which goes to show that there are great differences in the quality of them although their appearance may be quite similar.

When set in a crown they enable it to cut any rock known.

Granite is considered an easy rock to work in. The cutting is done by abrasion.

A leader and two assistants are required to attend to the bore, machinery, &c., and they work a shift of 9 hours at a time.

Boring commenced at Newton on the 19th December, 1889, and the bore had reached a depth of 149fms. 3ft. 10ins. by the 25th March, 1890, when it was stopped.

The work was only carried on during the daytime, and 16 shifts were lost on account of holidays, difficulty in getting bore tubes, &c., which reduced the actual working days to 67 during the above period.

The surface, 12fms. 5ft. 4in. in depth, was composed as follows, viz. :—

Fathoms.	Feet.	Inches.	
3	4	0	Sand and gravel.
0	4	0	Sand.
0	3	0	Clay.
0	2	0	Sand.
6	5	0	Gravel.
0	5	4	Sand and gravel.
12	5	4	

It was bored by the hand, and the following lengths of malleable iron tubes were put in, viz. :—

Fathoms.	Feet.	Inches.	
4	3	0	8in. tubes inside dia.
6	1	0	7in. „ „
13	1	0	5½in. „ „

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The latter were put down 2ft. into soft rock next the surface. Cores 4in. dia., and from a few inches up to 10ft. 8in. long were got until a depth of 133 fathoms was reached. At this depth a fault was crossed, and 45ft. of 4½in. tubes let down.

The size of the bore was reduced, and cores 3in. dia. were brought up for the remainder of the depth.

As showing the troubled nature of the strata passed through, the following variations in the dip and rise proved are given, viz. :—

First 40 Fathoms,	dip and rise	1 in 3½
Next 23	„	„	1 in 4
„ 67	„	„	1 in 4½
„ 4	„	„	1 in 2
Remainder,		„	Horizontal.

The fact that the dip and rise of the strata passed through is accurately shown at the partings is not the least of the advantages of this system of boring.

When boring in a good going strata the speed driven is 100 revolutions per minute, and in a fairly hard rock got at 30fms., 42ft. was cut in one shift of 9 hours. The harder the rock the quicker the cutting ; soft blaes being about the worst material in which to make progress.

During the time the bore is running, water is forced down the inside of the rods by the force pump, and the material abraded is carried up the outside, and delivered along with the water, either at the surface, or, as at Newton, to some open metals which were found at a depth of 27fms. from the surface, neither water nor borings coming to the top.

The samples of strata cut give a fair idea of the work a diamond bore performs, and so long as the material to be cut through is of the nature of sandstone, ironstone, shale or such like, perfect cores are got, but in cutting coal there is still room for improvement, as from the nature of the work any soft dirt ribs which may be in a seam are apt to be washed away, unless the dirt is all the harder in itself.

In this bore the Glasgow Upper coal was proved 3ft. 1in. thick, at a depth of 123½ fathoms, and the specimens got filled a box

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about 12ins. cube, many of the pieces being as large as a man's fist. This is a soft coal, and the samples showed that it was of a foul nature.

These facts demonstrate the superiority of this kind of boring over the old chisel system, besides which it is as cheap, and a prescribed depth can be guaranteed.

Messrs Thomson have every confidence that they will be able to devise means to get better cores of coal with soft partings.

DISCUSSION.

Mr ARNOTT, in reply to the President, said the site of the bore was down in the hollow on the north side of the mineral field of Newton, and, to Mr Beith, that they did not go through the different seams because they were in troubled metals all the time.

Mr DURIE said Mr Arnott's paper would be complete if he would give some idea of the relative cost of diamond and chisel boring.

Mr ARNOTT—It compares favourably with the chisel system.

The SECRETARY asked if Mr Arnott would apply the diamond boring to bores of 60 or 70 fathoms, where a number of that depth were to be put down.

Mr ARNOTT—Yes, if convenient to one another.

Mr BEITH—At what depth do you change the core?

Mr ARNOTT said they would have gone on with the 4 inch all the way had a trouble not come in.

Mr ATKINSON asked if a section of the whole bore could be had.

Mr ARNOTT said he thought so, but did not think it would be of any service, on account of the troubled state of the strata passed through.

Mr ATKINSON said although they got the dip of the metals Mr Arnott would not be able to judge in which direction it was.

Mr ARNOTT said he was not very sure if that could be done. The core was apt to revolve if it broke off before being drawn.

Mr JOHN LOVE said he understood that at the beginning the boring was with the chisel.

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Mr ARNOTT said going through the surface it was considered better. It was a very bad surface.

The discussion was adjourned.

THE PLACES OF MEETING.

Mr BEITH said, as the time was approaching when they would be arranging the meetings for next year, he would take the opportunity of expressing the opinion that, Hamilton being the birthplace of the Institute, had a right to have three meetings out of the nine. Then, he would say that Glasgow, being the main centre of industry in the West, was entitled to three also, and he thought it was as little as they could do to fix the remaining three for Edinburgh, it being the capital of Scotland. He thought such an arrangement would give every satisfaction to members resident in the Lothians and Fife, and he believed also that it would be the means of securing some valuable papers from them.

Mr JOHNSTONE said he supposed if Mr Beith's ideas were given effect to, the members in Fife and the Lothians would be prepared to contribute three papers in the year.

The PRESIDENT said he had no doubt Mr Beith's remarks would be duly considered by the Council.

PROPOSED COMMITTEE ON PUMPING.

Mr JOHN DURIE, as a member of the Institute belonging to the East, said they were all very grateful to the Institute for meeting there that day, and he would be glad if the suggestion to have regular stated meetings in Edinburgh were carried out. The weather and the disorganised state of the railway traffic, he was sure, accounted for the small number present. He did not know if he was quite in order, but there was one subject he had a great deal of interest in, viz., pumping. He wrote to the Secretary some time ago, suggesting an inquiry as to the relative efficiency

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of different kinds of pumping engines. If the Council could see their way to make an independent and exhaustive inquiry into the whole subject and report, the result would be very valuable. The means for pumping had been undergoing an entire change, and an independent body like the Mining Institute would have access to sources of information which no private individual could secure. The subject was becoming daily more important as mining advanced, not only to Scotland, but to the world at large. The Institute had prepared a report on the different systems of working coal, which he thought was productive of valuable information. They had also prepared a report on coal-cleaning, which was very valuable. He did not know how the funds for these investigations were raised; but if the funds required were heavy, and beyond the resources of the Institute, he was sure many people connected with mining would willingly subscribe for such an investigation, and he knew, for himself, he would subscribe £10 towards it.

The SECRETARY said he would like to say, as representing the Council in the matter, that they arranged this meeting by way of experiment to see to what extent the members in the East would turn out and show an interest in their meetings; and, considering the very stormy nature of the day, he thought the attendance of members not in the habit of meeting with them either in Hamilton or Glasgow was encouraging. He believed the Council would have the greatest pleasure in falling in with the proposal by Mr Beith, and arranging for a larger number of meetings away from Hamilton to meet the convenience of those who live at a considerable distance from it. As to what had fallen from Mr Durie, there was a committee formerly appointed to go into the question of pumping, but the matter was not carried through on account of the want of support given to the committee. It might be revived. The Council had recently arranged to make a collection of drawings with descriptions of all the kinds of hutches in Scotland. The members would be immediately asked to contribute to it, and he hoped they would all go into the matter heartily.

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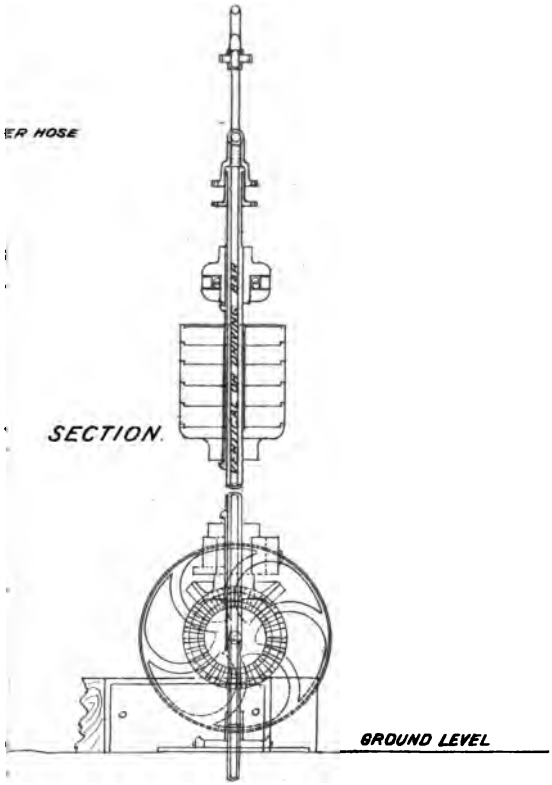

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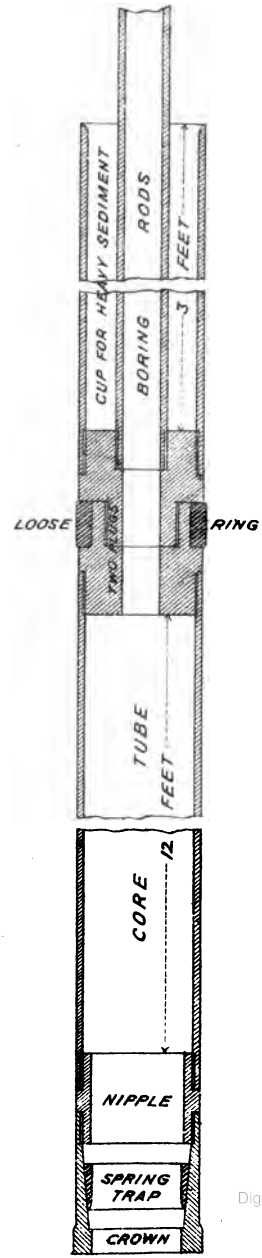

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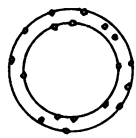

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THE MINING INSTITUTE OF SCOTLAND.

GENERAL MEETING,

HELD IN THE

ROOMS OF THE CHRISTIAN INSTITUTE, GLASGOW,

12th March, 1891.

JOHN M. RONALDSON, Esq., President, in the Chair.

THE minutes of the last General Meeting were read by the Treasurer, in the absence of the Secretary, and confirmed.

The following gentlemen, who had been duly nominated, were elected by ballot as ordinary members:—

JULES ELSNER, 80 Lombard Street, London, E.C.
ANDREW BAXTER, Coatbridge.
JAMES HOUSTON, Salsburgh, Holytown.
ROBERT BROWN, Newmills, Dunfermline.
THOS. GOODWIN, Newton Colliery, Newton.

Office-Bearers for Session 1891-92 were then nominated, in terms of Sec. 5, Art. 3, of the Rules.

The following discussions then took place:—

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DISCUSSION OF MR FAULDS'S PAPER ON "SHALE MINING AT OAKBANK."

Mr W. S. RUSSELL, referring to the branch roads for drawing (40 to 50 fathoms long) on p. 133, said he would like Mr Faulds to tell them to what extent the roof of the roads subsided in working that distance.

Mr FAULDS—About two-thirds, and sometimes more.

Mr RUSSELL—Had you not to back brush two or three times before you got that distance?

Mr FAULDS—Certainly; we were continually brushing it.

Mr RUSSELL said, from the experience he had had, more especially at Burntisland, they could not go anything like that distance without back-brushing at least two or three times.

The PRESIDENT—Does your seam correspond to this seam? You know seams vary very much.

Mr RUSSELL said the seam was over six feet, and he had seen the roof subside to less than two feet from the pavement. In fact, at 30 feet from the face a tub could not be got into it. He was rather surprised to find Mr Faulds going from 30 to 40 fathoms without back-brushing. Referring to the cost of timber, Mr Russell said that, at Burntisland, timbering cost much more than stated by Mr Faulds, and with a better roof than that referred to by Mr Faulds and he did not see how that distance could be gone without putting in more timber.

The PRESIDENT asked if they were not facts that Mr Faulds had given?

Mr FAULDS—Practical facts.

The PRESIDENT—So you cannot get over them.

Mr RUSSELL asked if Mr Faulds would kindly tell them if the cost for the timber in working the Dunnet seam was kept separately, or did it go in with the other work?

Mr FAULDS—It was kept separately, of course.

Mr RUSSELL said another thing Mr Faulds mentioned was that the shale should be picked the same as coal. Did he think it would be practicable to pick the shale, say with an output of 300 to 400 tons, in the same way as coal?

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Mr FAULDS—Yes, although you had a thousand tons, by having plenty of picking tables.

Mr RUSSELL—There must have been a great deal of dirt. He observed 10 per cent. He thought that should be explained, because there seemed to be a want of crow-picking, either on the surface or under-ground. He had had it from one to one-and-a-half per cent.

Mr FAULDS—There is a good deal of that they make oil of.

Mr RUSSELL said, in his experience he had found shale condemned simply because there were a good many stones in it. In that light he could quite sympathise with Mr Faulds, for it might be in that way he had the 10 per cent. dirt. Referring to p. 137, he said there was a section given of the Dunnet seam at Newliston, which seemed to him to be incorrect. The following is a section of the seam :—

Plain Shale, ...	9in.
Curly Shale, ...	13in.
Plain Shale, ...	24in.
Cement, ...	½in.
Blaes, ...	8in.
Shale, ...	20in.
Blaes, mixed with Ironstone Ball, ...	8in.
Shale, ... from 72in. to 100in.	

Mr Faulds also stated that the stoops near the surface were 40 feet square, and to the dip 60 feet; but they were larger than that; and, of course, the holing was not in the middle, but in the bottom. Then, as regarded the general section of the Broxburn District, at p. 140, the Burdiehouse or Camps Limestone was usually found about six fathoms underneath the Dunnet seam, as had been proved by bores. Mr Faulds's section of Newliston shale showed that it was holed in two ways. He should like to know where Mr Faulds got the middle holing.

Mr FAULDS indicated where Mr Russell would find the section as given on p. 137. He said he took it in presence of the late Mr Swan, and it was perfectly correct. The mid holing was also practically correct, but they could have different sections in

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different parts of a field. The general section of the Broxburn district was proved to be correct by the geological data given by Mr Cadell at the last meeting.

Mr RUSSELL, said there was no new holing in the mine. With regard to what Mr Cadell had stated, he had said his statement was only approximate. For the Broxburn district the facts were as he had mentioned, viz., about six fathoms.

The PRESIDENT said there appeared to be a conflict of evidence on the point, but it was perhaps not material for their discussion.

Mr DUNDAS SIMPSON, referring to Mr Russell's remark relative to the cost of the wood, said from his experience in working shale, he was very much struck when he saw how little it cost in Oakbank for wood. It was quite possible there was some disadvantage in the way of bad roofs at Broxburn, Uphall, and other fields; at the same time looking back over the past, he thought there was far too much wood consumed in shale workings. It struck him very forcibly if he had the same thing to begin now, he certainly would not use the amount he then did, because at present he was working coalfields longwall with a much worse roof with less wood. In the shale seams, according to Mr Faulds's paper, they could work a certain amount of the under seam, and then withdraw the props, allowing the upper leaf to fall. He said sometimes the main roof did come away, but not very often. He (Mr Simpson) was prepared to say he could not do that even in a coal working, but, taking it altogether, he thought there should be something done. They could not say they had not been guilty of putting too much wood in the workings. He questioned if the amount of wood built in had not something to do with the roads coming so far down, for with a soft pavement it would tend more to this than if it was only props that were put in at the face. Like Mr Russell, he thought the price was very little in comparison with the amount of timber Mr Faulds said was built into the working.

Mr FAULDS—It is a practical fact.

Mr SIMPSON said if so much wood were being put into these shale workings, what effect would the wood have upon the air when the wood became rotten?

The PRESIDENT—Put in plenty of air.

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Mr SIMPSON said even that would not prevent the air from becoming impure.

Mr R. T. MOORE said he knew the Dunnet seam workings at Oakbank very well. In comparing the cost per ton for timber with coal seams, it should be remembered that shale was heavier than coal, and that in coal workings there would be a half more roof exposed per ton worked. The chief trouble was in the level. The working was about 10 feet high, with a parting in the middle, and the weight had a tendency to come downhill, closing the level. He thought the method of working, which had been introduced by Mr Robert Calderwood, a very satisfactory one, and it enabled a large output to be got from a small area at a cheaper cost than by stoop and room.

Mr SNEDDON asked if Mr Russell would state if he had had the one to one and a half per cent. of dirt in actual experience.

Mr RUSSELL answered in the affirmative.

Mr SNEDDON—Then, I must say your lines have fallen in pleasant places, or that you have a very lenient oil works manager to deal with.

Mr RUSSELL was afraid it was a great mistake, for the simple reason that, although only from 1 to 1½ per cent. of dirt was actually got, still more than that proportion was taken from them by the oil works manager.

Mr MARTIN said the only point he noticed in the discussion of interest, so far as he could think of, was the matter of the cleaning of the shale. He thought it was Mr Love who remarked that it was impossible for any one to distinguish between shale and foreign matter. Now, from his experience that was not the case. A day or two's experience by any ordinarily intelligent man would enable him to distinguish at once in a hutch or on a table what was right and what was wrong. When a shale manager, he had had the grievance Mr Russell referred to, viz., of having more taken off him than he should have had. He thought the proper way to deal with shale was to put up a shaking screen, and have it not only to pass the stone but also the stour, they might call it. He knew for certain at Pentland when they took pains to compel them to sweep the shoots the results were very much better, simply because the pieces of fireclay and fine stuff were

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left in. It could be done very well at the top. He thought it better to shake the stour out of the shale, because so far as he could discover it had a bad effect on the retorts. It stopped the distilling process, and stuck to the sides, which was a nasty thing. He did not think the workings could be very well improved. If mechanical holing could be adopted, it might be worked in two seams long-wall.

Mr RUSSELL said he might state that the Broxburn Oil Coy. at one time fitted up screens at the pit to run the shale down, but it was not possible to run it down, because the ribs got choked up, and they had to hand pick it down.

Mr ROBERTS said when the fine shale went into the retort it choked it up, especially the Beilby & Young retort, where the gases were drawn up through the shale. Of course in the Henderson retort the gas went down, and the retort was not choked so easily. It was customary in shale works that the miners should riddle the shale, but it was not an easy matter to get them to do it, unless they had an inspector standing beside them.

The discussion was adjourned.

DISCUSSION OF MR ARNOTT'S PAPER ON "A DIAMOND BORE AT NEWTON COLLIERY."

The PRESIDENT said Mr Arnott wrote that he was sorry he was unable to be present. If there were, however, any questions put, he would be glad to answer them afterwards.

Mr W. S. RUSSELL said the bore seemed to have gone down pretty quickly, and he would like if Mr Arnott could get the Messrs Thomson to state the difference between boring in the shale fields and boring in the coal fields. He found, in some of their diamond bores which they had at present in operation, they could not put them down anything like two fathoms a day. Lately they put down one of 176 fathoms in thirteen weeks two days, with two shifts. The largest day's boring was over 50 feet with one shift. The metals were sandstone, but,

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coming to the blaes, there was no boring at all. Sometimes it would take them very good work to cut four feet. He understood that chisel boring could be done for about the same cost as diamond boring.

Mr ATKINSON said he would like if Mr Arnott would give the percentage of core extracted—that was to say, the proportion of core to the distance bored, and also the percentage of coal core for the coal bored through. He noticed in other papers on diamond boring these figures had been given.

Mr WADDELL pointed out that at p. 157 Mr Arnott stated the core got from the coal was not satisfactory.

The PRESIDENT suspected that a good deal would depend on the nature of the strata. There was one point he was not quite clear on, viz., as to how the spring trap (p. 155) got hold of the core.

Mr RUSSELL having explained the process, in answer to Mr Ralph Moore, he said if a small piece of stone was put down the tube, it would at once stop the boring, because the tubes were so small.

Mr RALPH MOORE—You do not know of it being done?

Mr RUSSELL—No, it could not be done.

Mr RALPH MOORE—I know it is done. Can you with a diamond bore tell as distinctly as with a chisel when you come to a variation, a change in the strata?

Mr RUSSELL—Yes, you can tell that.

Mr ATKINSON asked if Mr Russell could tell if they got a perfect core out of the shale with a diamond driller.

Mr RUSSELL—If in hard measures we can take perfect cores. He had seen them standing about 9ft.

Mr ATKINSON—I am referring to the shale seams.

Mr RUSSELL said in some places their core, or a great part of it was washed away.

Mr ROBERTS said when the Broxburn Company started their diamond boring the cores as he saw them come out of the shale were very imperfect. They never got anything above a foot or a foot and a half in length. The diamond system of boring is certainly the best method for proving shale.

The discussion was adjourned.

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The following paper on Joseph Moore's Patent Hydraulic Pumping Arrangement was then read by Mr Robt. Thos. Moore.

JOSEPH MOORE'S PATENT HYDRAULIC PUMPING ARRANGEMENT.

By Mr Robt. Thos. Moore, B.Sc., Civil and Mining Engineer.

In January, 1884, the writer read a paper to the Institute describing this arrangement, and he has now much pleasure in complying with the request of the Council to give a few additional remarks upon it.

As there may be many of the members who have not read the former description, it may be well briefly to describe the system again.

The arrangement enables two columns of water to be substituted for the ordinary solid rods connecting the steam engine to the pump.

The action will readily be seen from the diagram, Fig. 1.

On the surface is a cylinder *A B*, in which travels a piston *P* driven by the tumbling crank of a steam engine.

Underground there is a cylinder *C D* exactly similar to *A B*. The piston *Q* which travels in it, is connected to an ordinary double acting pump. There is a pipe *F* from the end *A* of the cylinder *A B* to the end *D* of the cylinder *C D*, and another *E*, from the end *B* to the end *C*.

The pipes and the cylinders are both full of water. When the surface piston *P* moves from *A* towards *B*, the water is forced out of the *B* end of the cylinder, through the pipe *E* to the *C* end of the cylinder underground, and the piston *Q* is driven from *C* to *D*. When the stroke on the surface is reversed, the piston underground is forced in the reverse direction, and the motion is thus transferred from the engine on the surface to the pump underground, in the same way as would have been done had there been two wooden rods instead of the two columns of water.

Should there be any leakage in one of the power pipes, the plunger at the bottom would make a shorter stroke in the one direction than in the other, and would work towards the end

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and, unless there was some regulator, would knock the end off the pump. This is obviated by having valves worked by tappets set at such a distance that, when the stroke is completed, they are opened, and the water allowed to pass from one power pipe to the other, thus adjusting the stroke of the rams.

On the diagram, Fig. 1, it will be seen that the pipe *G H* connects the two power pipes *E* and *F*. In this pipe there are two valves *J* and *K* opening in opposite directions—*J* closing against pressure from the power pipe *E*, and *K* against pressure from *F*. These are opened by tappets *M* and *L*, which are set apart a few inches more than the length of the stroke. Suppose that there is a leak in the power pipe *E*. When the piston *P* is travelling towards *B*, some of the water from *B* will be lost, and the piston *Q* will not make its full stroke, but will stop short of *D*. In the return stroke, when the piston *Q* has travelled as far as it can without striking the end of the cylinder, and before the piston on the surface *P* has completed its stroke, the knob *S* strikes the tappet *L*, and opens the valve *K*. This allows the water from the power pipe *F* to lift the valve *J*, and run into *E*, immediately making the same pressure on both sides of the piston *Q*, and stopping it—the water displaced by the remaining portion of the stroke of the piston *P* passing through the valves from the one power pipe to the other. When the surface stroke is reversed, the pressure comes on the top of the valve *J*, and the piston *Q* is forced from *C* to *D*. In this way the pistons are kept in their proper position, and the normal stroke assured.

The power pipes are kept charged from a tank placed above the level of the highest point. There is a valve opening inwards on each of them, and when the piston *P* is making the return stroke, enough water is sucked in to make up any leakage.

It will thus be seen that the adjustments are automatic, and in practice they are found to be very complete.

It will also be seen that by this arrangement the steam engine may be placed at any convenient position on the surface, and it will work a pump placed anywhere in the shaft or in the workings. It has been put to work a pump throwing 165 fathoms vertical (with 800 yards between the steam engine and the pump), but it

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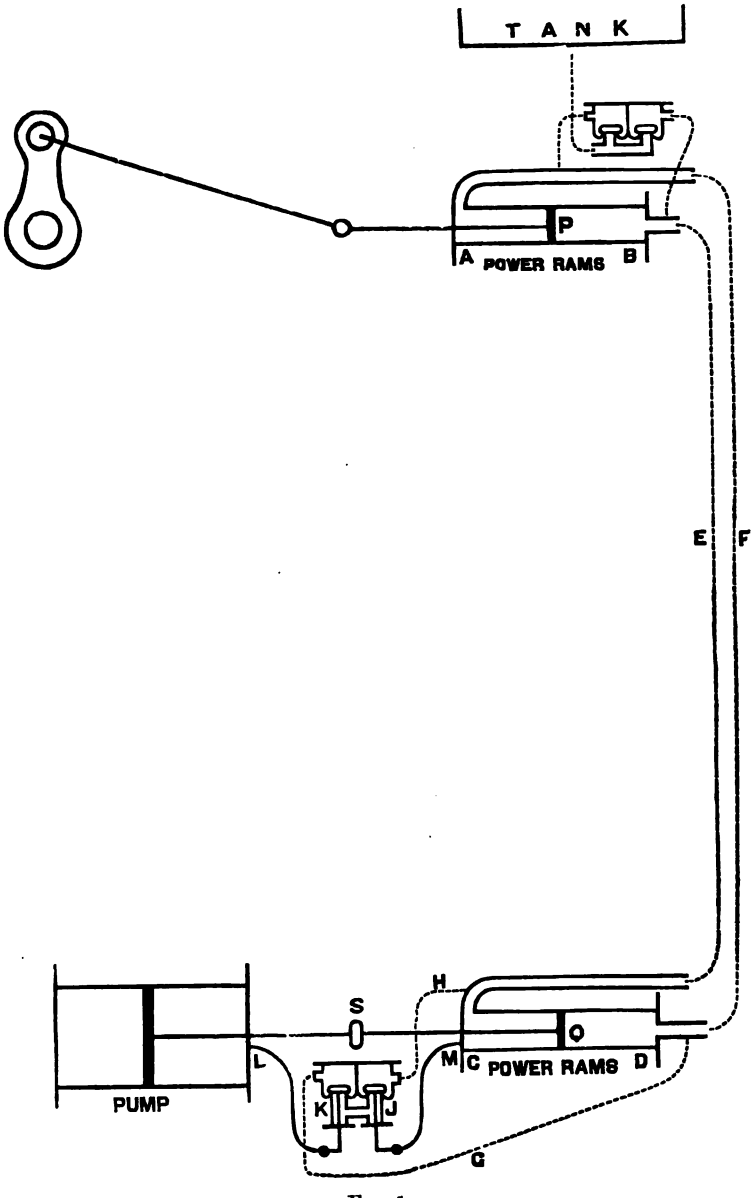

FIG. 1.

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is found most advantageous to make the vertical lifts not more than 100 fathoms, as the weight of metal in the pumps and power rams and pipes is as much for one pump to throw 200 fathoms as for two to throw 100, and, as the pumps can be placed at any convenient point in the shaft, there is not much difficulty in putting them out of the way. Any form of steam engine, and any form of pump, may be used for the system.

It is always desirable that a pump should run slow, and it has been our practice to adopt geared engines, so that the speed of the pumps is slow, while the engine runs at its normal speed. It has also been our practice to use rams instead of pistons in the pumps, as well as the power plungers. The power rams are made of such a size that the pressure on the power pipes is 1000lbs. per square inch.

Plates VI. and VII. illustrate a pumping arrangement fitted up at Messrs John Nimmo & Son's Balquhatstone Colliery, Slamannan, and shows the form found to be most suitable. The pumps are placed at the bottom of a vertical shaft 70 fathoms deep, and throw 650 gallons a minute to the surface.

In order better to balance the engines, two separate sets of double acting ram pumps, 12in. diameter and 4ft. stroke, are worked from the same crank shaft, the cranks driving the surface power rams being placed at right angles to each other. These are both the same, and a description of one will do for both.

There is a connecting rod between the two surface power rams and the tumbling crank. At the pump there are two power rams —each half the area of the surface power ram—on each side of a crosshead, which works the pump plungers.

The details are as follow :—

Steam pressure, 80lbs. per sq. in. ; engine (compound), cylinders 15in. and 27in. diameter, 4½ feet stroke ; gearing 5 to 1, the large wheel being 10ft. diameter ; top power rams 5⅞in. diameter, 4ft. stroke ; bottom power rams (double) 4in. diameter, 4ft. stroke ; plungers, 12in. diameter, 4ft. stroke ; power pipes, 2¾in, bore, ⅜ of an inch thick.

The regulating valves are worked by the tappets *A B* (Plate VII.) which are moved by the crosshead.

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The cistern and inlet valves are shewn on the drawing of the surface arrangement at *C* and *D* (Plate VI.)

The engine in this case was made by Messrs Inglis & Hossack, engineers, Airdrie, and the gearing and pumping arrangements by Messrs Gibb & Hogg, Limited, engineers, Airdrie.

Fig. 2 shews the arrangement of two of these pumps, which were erected by Messrs Gibb & Hogg for the Shotts Iron Co. at Mauricewood, near Penicuik. The surface arrangement is the same as at Balquhatstone. One of the pumps, 10in. in diameter and 4ft. stroke, is placed 160 yards from the bottom of a vertical shaft, down a dook dipping at 50 degrees, and the other, a pump 8in. in diameter, is placed 160 yards further down the dook.

Diagrams taken from these pumps shew that in the 10in. pump 66·26 per cent. of the work shewn in the indicator diagram of the steam engine is got out of the pump.

The power lost in the friction of the engine, gearing, and surface power rams is 10·24 per cent.; that lost in transmitting the power through the power pipes is 14·36 per cent; and that lost in the friction of the underground power rams and pumps, 9·12 per cent.

In a 7in. pump which was erected at Pentland, to force 165 fathoms vertical with 800 yards between the pump and the steam engine, the work done by the pump was 68 per cent. of the work shewn in the indicator diagram of the steam engine.

These figures compare very favourably with the results given for the transmission of power by electricity and compressed air, where the useful effects given are—for electricity, 44·4 per cent.; and for compressed air, 25 per cent.

The pumps at Mauricewood were put in to replace direct-acting steam pumps, driven by steam led down the pit and the dooks, from a range of seven steam boilers on the surface, which in addition, supplied steam to the other engines about the colliery. I am informed by Mr Love, the colliery manager, that when the steam pumps were replaced by the hydraulic arrangement, the other engines being the same, the monthly consumption of coal was reduced from 859 to 567 tons; shewing how much more economical the system is than taking steam underground to drive direct-acting steam pumps.

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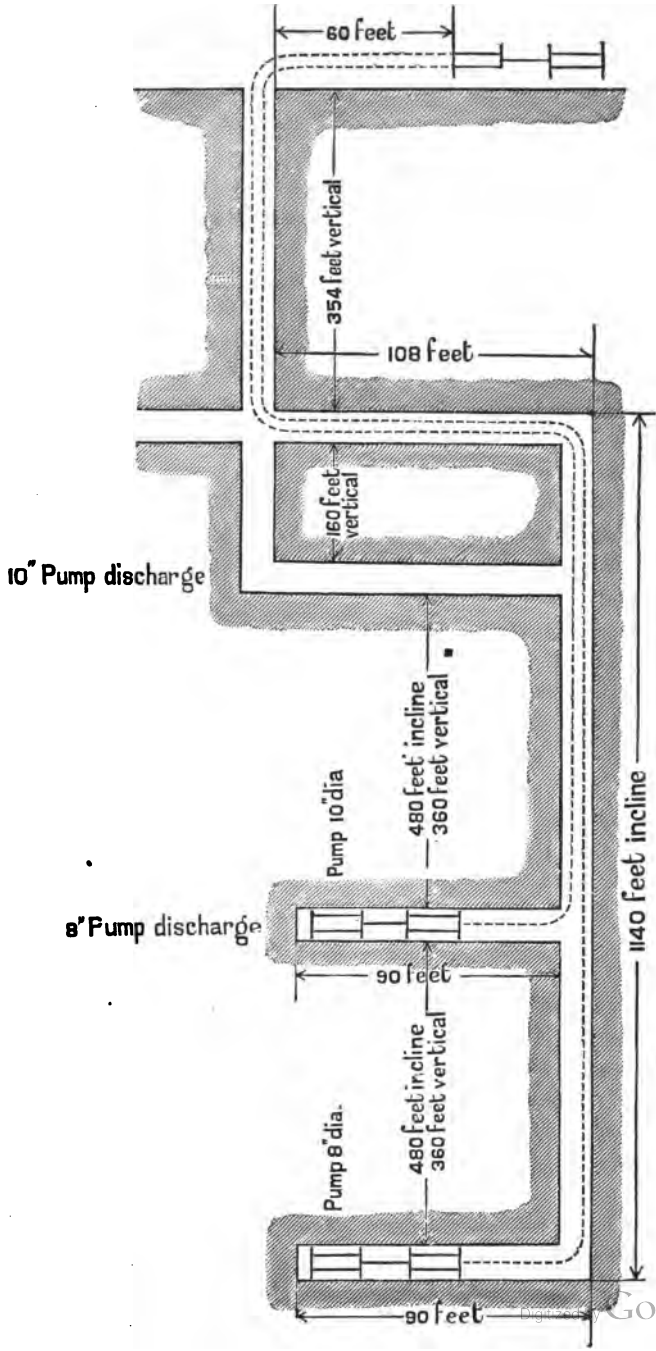

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FIG. 2.—Diagram showing Position of Pumps at Mauricewood.

It is worth noting that the Mauricewood pumps have now been in operation for six months, and the stuffing boxes have never been touched since they commenced.

There is now a large number of these hydraulic pumps at work both for vertical lifts and for dooks, and they all give satisfaction.

Some of the advantages of the system are the large percentage of useful effect got from it. The engine and pumps can be put away from the shaft, leaving the pithead and pitbottom unobstructed, and the shafts clear of any moving pitwork. The saving of room will be apparent when it is stated that with the Balquhatstone pump there are only four lines of 3½in. pipes in the shaft to drive pumps throwing 650 gallons a minute 70 fathoms vertical.

In inclined and dip workings the power pipes may be led round any number of bends. The parts underground are of the simplest description, and not liable to go out of order, and there is no need of an attendant.

The pump will work though covered with water. Another advantage, and a very great one, is that the small amount of room the arrangement takes up facilitates the erection of duplicate arrangements, whereby should any breakdown take place the pumping could be continued by one of the engines until the repairs were completed. At present, such an arrangement is being put in at Pentland mines, where a breakdown of the pumping engines has caused great inconvenience.

Duplication of pumping machinery has not received the attention it deserves. It is not necessary that the machinery which is not liable to break down should be duplicated. The same boilers, and in some cases the same engines, might be arranged to work either of the sets of pumps, and the cost of the duplicate erection is a cheap insurance against loss from breakdowns. In many cases it would be cheaper to put in duplicate pumping arrangements than to make extensive lodgments, and there is always very much greater security when it is done.

Mr J. W. F. ASHWIN then exhibited and gave the following description of the Pulsion Telephone :—

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THE GLASGOW AND DISTRICT PULSION TELEPHONE.

By Mr J. W. F. Ashwin.

The Pulsion telephone is a new mechanical telephone of great power and clearness, and was invented by Mr Mellett, of Boston, U.S. of America. This telephone is perfectly independent of electrical aids, and so does not suffer from induction, or cross talking as it is commonly called, which unfortunately is the case with electrical telephones. The instrument is of very simple construction, forming both transmitter and receiver, and consists of a circular wooden box, about five inches in diameter, and about three inches in depth, and having a circular aperture at each end. Just inside the front end, into which a mouthpiece is fitted, is a metallic disc, having a small hole in the centre, and immediately behind the disc are arranged circumferentially a number of small coiled wire springs, held at one end only, and free to vibrate when actuated by any external impulse, these springs being connected altogether by other coiled wire springs. The springs are so arranged that they produce harmonised vibrations, and their function is to magnify or accumulate upon the line wire the vibrations set up by sounds acting upon the disc, to which the line wire is attached by means of a brass button. These sounds are transmitted by the line wire to a second and similar instrument, at which the sounds are heard very distinctly and at a considerable distance from the instrument, according as they are powerful or otherwise. Musical notes are transmitted with equal facility and clearness, whether produced by the voice or by instruments. Having described the instrument, and shown how simple it is, it will readily be seen how simple it is to use, having just a mouthpiece to speak into, and nothing to hold to the ear, the voice being distinctly audible at some feet from the instrument. No bells are required, unless when the instrument at either end is placed in a room usually unoccupied, merely whistling a call or tapping on the bottom inside the mouthpiece being quite sufficient to attract attention throughout a large room. The uses to which this telephone is already applied are so numerous that I cannot enumerate them all, but

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will only point out how useful it is found connected between colliery offices and weigh cabins, the manager's house and office, offices and pithead, in various ways underground, and in many other ways about the works. And I must not omit one feature of it, viz., that, by placing a hard hat on the wire conversation can be carried on to the instrument at either end of the line.

DISCUSSION.

In answer to Mr Ralph Moore, Mr ASHWIN said the telephones were not sold right out. They put them up for a rental of £2 10s the first year, and £1 10s each succeeding year, for a distance under 400 yards, and maintained them for the same amount.

Mr R. T. MOORE asked if there was any limit to their speaking.

Mr ASHWIN said they were guaranteed to speak up to three miles.

Mr RALPH MOORE asked how they did with attachments when they went round a corner.

Mr ASHWIN said they just carried the wire on little loops of wire or on wooden spools. They did not use insulators.

Mr R. T. MOORE—It does no injury by lying against the wall?

Mr ASHWIN—You must not allow the wire to touch the wall.

Mr MITCHELL asked if it was the case that they heard the telephone down the post.

Mr ASHWIN answered in the negative. One advantage of having it down an incline was, where there was an endless chain, by tapping on the wire, they could have the engine stopped at once.

Mr ATKINSON said he remembered four or five years ago a mechanical apparatus being in operation at Herd Colliery, South Shields. He did not know if it was the same as this one.

Mr ASHWIN said it was not, as this one had only been in England for two years.

Mr ANDERSON—Will it be affected by damp?

Mr ASHWIN—No, not at all.

The PRESIDENT—It seems a very simple instrument.

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Mr ATKINSON asked if the telephone was in use at any colliery.

Mr ASHWIN said it was down the Coltness Coy.'s Branchal mine.

Mr RALPH MOORE said Mr Miller, the Secretary of the Institute of Engineers and Shipbuilders, about ten years ago invented a similar apparatus which transmitted sound without electricity.

The discussion was adjourned.

Mr A. ERSKINE MUIRHEAD, then exhibited, and gave the following description of the Ader French Telephone :—

THE ADER FRENCH TELEPHONE.

By Mr A. ERSKINE MUIRHEAD.

With the expiry of the Bell telephone patent in December last, quite a number of new types have been introduced into this country. The French and German Governments declined to grant patents, except in a qualified way, as both countries claim that their country has produced prior discoveries of this instrument. Be that as it may, free trade in telephones has existed there for the last decade, and, as a result, competition created improvements.

One of these is the "Ader" telephone.

It consists of a little circular box, in which is placed a circular compound magnet, with a thin iron diaphragm. This diaphragm is made much more sensitive by being placed between a super-exciter—a magnetic arrangement, the invention of M. Ch. Ader, of Paris.

Its sensibility is such that speech can easily be reproduced over 10 miles by the dynamic force of the voice acting on the diaphragm, which sets up an electric current which traverses the line wire and sets up a similar set of vibrations on the distant telephone, at which the hearer's ear is placed, thus—

The voice impinging on the diaphragm at *A*, sets up an electric current in the coils in that telephone. This current traverses the

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line to *B* telephone, where it reconverts itself from an electrical to a mechanical force, and sets up vibrations in the diaphragm in the *B* telephone which the ear is able to hear; and similar action at *B* telephone has the same effect at *A*.

This telephone may readily be adopted in mines, specially those which have already electric signalling wires fixed underground.

For example, we have the two wires—

When the signal bell has to be rung at the pithead or elsewhere, all that is required is to close the circuit by either touching the two wires together or by laying a piece of metal across them.

Now, by the following arrangement one or more telephones can be put on these same wires without in any way interfering with the signal bell, beyond using it as a call to attendant to use the telephone by a pre-arranged signal, say two long and two short rings of the signal bell.

Suppose there are four telephones—*A*, *B*, *C*, *D*,—with bells strung on one wire. When one bell rings all the others ring, but each has a special signal. This enables the pithead or any station to speak to any other. But by dispensing with bells at each telephone, all the stations can call up the pithead, but not *vice versa;* but either system can be adopted throughout, or for special stations in the workings.

One wire of the telephone is fixed to one of the signal bell wires. The other telephone wire goes to earth, and does not touch the return signal bell wire at all, so that there can be no interference with the important functions of the signal bell, which is at all times available, even while a conversation is being carried on; or, instead of putting the telephone wire to earth, a third wire could be run.

As no battery is required for speaking, there can hardly be any possibility of the telephone getting out of order, unless the wire be broken or getting earth; even then, on account of the high electro motive force of telephone currents, they will pass where battery currents would be stopped.

In the event of communication requiring to be made from any part of the workings, a portable form of instrument is easily applicable. This is done by fixing the telephone to a dry cell,

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made specially for this purpose in France, called *pile bloc.* With this battery the bell on the pithead can be rung and the communication established by the afore-mentioned plan.

It is safe to say that there will be quite a new era in underground communication by means of the telephone and wires made of silicium bronze, which has very great mechanical strength—a wire *1 mm. sq. having a tensile strength of 200 lbs.

DISCUSSION.

In reply to Mr Ralph Moore, Mr MUIRHEAD said as to the cost, it was only during the last month the instrument could be sold at all. The telephones cost about one pound sterling.

Mr G. A. MITCHELL asked if it was not the case that they required to speak much more loudly with this than the other telephone.

Mr MUIRHEAD—Yes, and closer. They could not hear a whisper. He explained, in reply to Mr Mowat, that it could be attached to the present bell arrangements in collieries, and said, in answer to Mr Ralph Moore, that a man could carry one of the instruments in his pocket.

The discussion was adjourned.

*1 mm. = 1-25th of an inch.

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The Mining Institute of Scotland.

1890-91.

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RONALDSON, JOHN M., H.M. Inspector of Mines, 44 Athole Gardens, Glasgow *(President)*, - -	1879
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Brown, Thomas M., Lanemark Colliery, New Cumnock, - 1880
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Brown, William, Largoward, St. Andrews, - - 1888
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Buchanan, Col. D. C. R. C., Drumpellier, Coatbridge, - 1881

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Cameron, William J., Finnie Street, Kilmarnock, - 1885
Campbell, Archibald, Redding Collieries, Polmont Station, 1883
Carlow, Charles, The Fife Coal Company, Leven, - - 1879
Clark, James, Ormiston Station Colliery, Ormiston, - 1880
Clark, Robert, Arniston Colliery, Gorebridge, - - 1883
Colquhoun, James, Tredegar Iron Works, South Wales, - 1882
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Coats, William A., Ferguslie House, Paisley, - - 1884
Craig, Allan, 62 Dundonald Road, Kilmarnock, - - 1890
Cross, James, 445 Eglinton Street, Glasgow, - - 1890
Cuninghame, Alexander, Carnbroe Iron Works, Coatbridge, 1880
Cuninghame, J. C., 127 St. Vincent Street, Glasgow, - 1879
Cuninghame, John, 127 St Vincent Street, Glasgow, - 1879

Dalzell, John B., Portland Park, Hamilton, - - 1881
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Durie, John, Elphingston Colliery, Tranent, - - 1880

Ferguson, Peter, 19 Royal Exchange Square, Glasgow, - 1885
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Forster, T. E., North Jesmond, Newcastle-on-Tyne, - 1890

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Galloway, Robert L., 43 Mair Street, Plantation, Glasgow, 1884
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Gilmour, Allan, Portland Colliery, Kilmarnock, - - 1879
Glen, Robert, Eastfield Colliery, Cambuslang, - - 1881
Gordon, Gavin C., Wishaw Iron Works, Wishaw, - 1878
Grant, A. M., Townholm Engine Works, Kilmarnock (*Councillor*), - - - - - 1884
Gray, Archibald, Middleton House, Dalry, Ayrshire, - 1883
Gray, Archibald, 55 Eglinton Terrace, Ardrossan, - 1881
Gray, James, Riverside, Old Cumnock, - - - 1890
Gray, John, Spencerfield House, Hamilton, - - 1882
Grierson, Thomas, Glebe Colliery, Douglas, - - 1881

Haggie, P. S., Gateshead-on-Tyne, - - - 1887
Hall, Richard James, Union Gold Mining Company, Moodie's, Transvaal, So. Africa, - - - 1890
Hamilton, J. B., Bourtreehill, Hamilton, - - - 1888
Hamilton, Lord, of Dalzell, Motherwell, - - - 1881
Hamilton, Robert, Derwent Villa, Crosshill, Glasgow, - 1887
Harrower, D. K., Bo'ness, - - - - - 1889

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Hastie, Jas., Greenfield Colliery, Hamilton (*Vice-President*), 1878
Hill, Alexander, 20 Rua de S. Paulo, Lisbon, - - 1883
Hill, Laurence, 2 Alfred Terrace, Hillhead, Glasgow, - 1883
Hodson, James, Liverpool Road, St. Helens, Lancashire, - 1880
Hogg, John, Orchard Street, Motherwell, - - - 1878
Hogg, John, Victoria Engine Works, Airdrie, - - 1884
Hood, Archibald, 6 Bute Crescent, Cardiff, - - 1879
Hood, James A., Rosewell, Midlothian, - - - 1887
Hugh, James, Priory Lodge, Blantyre, - - - 1889
Hurll, Mark, Letterick Colliery, High Blantyre, - - 1880
Hyslop, Jonathan, The Cottage, Airdriehouse, Airdrie, - 1881

Irvine, C. M'Laren, Fence Colliery, Blackwood, Lesmahagow, - - - - - - - 1880

Jamieson, James Auldjo, 66 Queen Street, Edinburgh, - 1885
Jaquet, John Blockley, 8 Alwyne Square, London, N., - 1891
Johnstone, Hugh, 2 Boswell Terrace, Glasgow, - - 1879
Johnstone, Ronald H., 75 West Nile Street, Glasgow, - 1879

Keith, Daniel, Arden Lime Works, Barrhead, - - 1883
Kesson, Andrew, Clydebank House, Bothwell, - - 1885

Laird, Andrew, 123 St. Vincent Street, Glasgow, - 1883
Landale, Dr. David, the Binn, Burntisland, - - 1883
Lewin, Henry W., 154 West Regent Street, Glasgow, - 1882

M'Callum, John A., jun., 12 Waterloo Street, Glasgow, - 1887
M'Connell, J. I., Burnfoot, Sanquhar, - - - 1889

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M'Creath, George W., 208 St. Vincent Street, Glasgow, - 1879
M'Creath, James, 208 St. Vincent Street, Glasgow, (*Past President*), - - - - - - 1879
M'Culloch, David, Vulcan Works, Kilmarnock, - - 1885
M'Culloch, John, Loganlea Colliery, West Calder, - 1879
M'Donald, Symington, The Great Kanawha Colliery Co. (Limited), Mount Carbon, West Virginia, U.S.A., - 1880
M'Gill, John, 21 Pitt Street, Glasgow, - - - 1890
Mackay, Andrew, Grangemouth Coal Co., Grangemouth, - 1879
*M'Kenzie, Kenneth, New Bank Colliery, New Cumnock, 1880
M'Kenzie, William, Newbattle Collieries, Dalkeith, - 1880
M'Killop, James, Slamannan, - - - - 1886
M'Kinnell, William, Clyde Steel and Iron Works, Sheffield, 1887
M'Laren, Robert, Bonny, Uddingston (*Councillor*), - 1882
M'Laren, William, Orchards, Bellshill, - . - 1884
M'Lauchlan, J. D., 19 St. Ninian's Terrace, Morningside Drive, Edinburgh, - - - - - 1882
M'Naughton, James, Egidia, Irvine, - - - 1880
M'Pherson, Gilbert, jun., Stair, Ayrshire, - - - 1887
Miller, W. M., 34 St. Andrew Square, Edinburgh, - 1889
Mitchell, George A., 67 West Nile Street, Glasgow (*Councillor*), - - - - - 1881
Moore, F. W., c/o Wormald & Co., Govan, - - 1889
Moore, Robert T., 160 Hope Street, Glasgow, - - 1880
Morison, John, Newbattle Collieries, Dalkeith, - - 1879
Morton, James, Manor Park, Blairhill, Coatbridge, - 1880
Mottram, T. H., 6 Doune Quadrant, Glasgow, - - 1889

* Deceased.

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Mungall, Henry, Cowdenbeath Collieries, Cowdenbeath, - 1880
Munro, R. D., 141 Buchanan Street, Glasgow,- - - 1883
Murray, Robert, Blinkbonny, Bo'ness, - - - 1889

Nasmyth, A. H., Donibristle Colliery, Crossgates, Fife, - 1880

Nasmyth, J. A., Donibristle Colliery, Crossgates, Fife, - 1880
Neilson, George, Summerlee Iron Works, Coatbridge, - 1880
Neilson, John, Summerlee Iron Works, Coatbridge, - 1883
Nimmo, John, 12 St. Giles Street, Edinburgh, - - 1885
Ormiston, A. R., Gartness Coal Coy., 19 Waterloo Street, Glasgow, - - - - - - 1880
Ormiston, James, Mount Vernon, Glasgow, - - 1880

Park, John, Stonelaw Colliery, Rutherglen, - - 1881
Paterson, Rev. T. M. B., Ardenclutha, Hamilton, - - 1888
Paul, James, 7 Shandwick Place, Edinburgh, - - 1879
Penman Robert, 377 Dalmarnock Road, Glasgow, - 1887
Pettigrew, Robert, Gartlea House, Airdrie, - - 1881

Rankin, John jun., Drumgray Colliery, Airdrie, - - 1881
Rankine, David, 75 West Nile Street, Glasgow, - - 1879
Ritchie, Robert, Silver Queen Mines, Mount Zeehan, Trial Harbour, Tasmania, - - - - 1888
Robertson, David, 21 Pitt Street, Glasgow, - - 1880
Robertson, D. A. W., Metropolitan Coal Coy., Helensburgh, Illawara Line, New South Wales, - - - 1882
Robertson, Dr. J. R. M., Linton, Wilson's Point, Sydney, New South Wales, - - - - - 1886
Ronaldson, J. H., Mount Kembla, Wollongong, N.S.W., - 1879

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Rowan, Walter, Dundee Natal Coal Coy., Natal, South Africa, - - - - - - 1890
Roxburgh, Alexander, Alloa Coal Co., Alloa, - - 1880
Roy, William, Lauchope Colliery, Holytown, - - 1879
Russell, Archibald, jun., Avongrange, Hamilton, - - 1882
Russell, George, Summerlee Iron Works, Coatbridge, - 1883
Russell, P. B., Newfield, Hamilton, - - - 1887
Russell, Robert, Coltness Iron Works, Newmains, - 1878
Russell, William F., 175 West George Street, Glasgow, - 1890
Ruthven, the Hon. Walter, Barncluith, Hamilton, - 1890

Scott, William, 20 Drummond Place, Edinburgh, - - 1888
Scoular, George, Hewingham, Whitehaven, - - 1889
Sharp, Robert, Coatbridge, - - - - 1886
Smart, James, Balgreen, Hamilton (*Vice-President*), - 1879
Smith, Eustace, jun., St. Lawrence Ropery, Newcastle-on-Tyne, - - - - - - 1885
Smith, George W., Port Elizabeth, South Africa, - - 1883
Stafford, Thos. W., 1 Lea Road, Heaton Chapel, Stockport, 1885
Stevenson, Hugh, 21 Clyde Place, Glasgow, - - 1884
Stewart, Alex., Tharsis Mines, Huelva, Spain, - - 1877
Stokes, John, Tollcross Colliery, Tollcross, - - 1890
Strain, Hugh, Rigg Colliery, Airdrie, - - - 1887

Terris, Henry, Clackmannan Colliery, Clackmannan, - 1880
Tilden-Smith, B., 12 and 14 O'Connell Street, Sydney, - 1890
Thomson, Charles, Calder Iron Works, Coatbridge, - 1879
Thomson, David, Craigderran House, Cardenden, - 1887
Thomson, Thomas 38 New Row, Dunfermline, - - 1884

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Thorneycroft, Wallace, Merryton Colliery, Hamilton, (*Councillor*), 1887
Thornton, Peter, Crofthead, Fauldhouse, - - - 1878
Todd, John, Wellshot, Kilsyth, - - - - 1888
Torrance, James W., 81 St. Vincent Street, Glasgow, - 1881
Turnbull, A. W., 27 Charlotte Street, Leith, - - 1890

Waddell, Robert, 11 West Regent Street, Glasgow, - 1880
Waldie, James F., 53 Waterloo Street, Glasgow, - - 1883
Walker, James, 66 Waterloo Street, Glasgow, - - 1883
Walker, James P., Dalmellington Iron Works, Ayrshire, - 1880
Walker, William H., Springwells Colliery, Airdrie, - 1880
Wallace, James, Wester Gartshore Colliery, Kirkintilloch, 1882
Watson, John, Earnock, Hamilton, - - - 1879
Watson, William, Bank Street, Coatbridge, - - 1886
Weir, Alexander, Fireclay Works, Castlecary Station, - 1881
Weir, Thomas D., Ferro, Carril Central de Venezuela, Carácas, Venezuela, - - - - 1884
Wemyss, R. G. E., Wemyss Castle, East Wemyss, - 1890
Whitelaw, Thomas, Dalzell Colliery, Motherwell, - - 1879
Whyte, Robert, 15 Gordon Street, Glasgow, - - 1887
Wilson, Andrew, Dalzell Estate Office, Motherwell, - 1880
Wilson, John, Alderston, Mid-Calder, - - - 1881
Wilson, John, 69 Great Clyde Street, Glasgow, - - 1879
Wilson, Robert M., Anchorage, Bothwell, - - 1889
Wood, James, 40 St. Enoch Square, Glasgow, - - 1880
Wylie, John, Clifton Iron Works, Coatbridge, - - 1883

Yates, Andrew, Grange Colliery, Kilmarnock, - - 1881

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Young, John, Baljaffray Colliery, New Kilpatrick, - 1881
Young, Robert, 37 West George Street, Glasgow,- - 1882
Young, Robert, 42 Bath Street, Glasgow, - - - 1888
Young, William, 204 Stobcross Street, Glasgow, - - 1885

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ORDINARY MEMBERS.

Subscription, 10s 6d.

Addie, Alexander, 67 Johnston Street, Airdrie, - - 1888
Addie, William, 22 High Street, Blaenavon, Mon., - 1889
Alison, Robert, Leafield, Burnbank Road, Hamilton, - 1890
Allan, John, Calder Iron Works, Coatbridge, - - 1881
Allardice, James, Eastfield Colliery, Cambuslang, - - 1881
Anderson, David, Cowdenbeath Colliery, Cowdenbeath, - 1881
Anderson, George, Ferniegair Colliery, Hamilton, - 1885
Anderson, James, Hassockrigg Colliery, Whitburn, - 1890
Anderson, John, Lochgelly Iron and Coal Co., Lochgelly, 1880
Andrew, Robert, Minas de Aznacollar, Seville, Spain, - 1880
Andrew, William, Lassodie Colliery, Dunfermline, - 1880
Archibald, David, Mossend, West Calder,- - - 1888
Archibald, Robert, Blackhill Colliery, Maryhill, - - 1890
Archibald, William, Westburn Colliery, Cambuslang, - 1879

Bain, James, Brownrigg Colliery, Longriggend, - - 1889
Baird, Dugald, Leven Collieries, Leven, - - - 1887
Baird, James, Carnbroe Iron Works, Coatbridge, - - 1890
*Baxter, Robert, Niddrie Collieries, Portobello, - - 1880
Beaton, Henry, Balbardie Colliery, Bathgate, - - 1889
Beith, Robert, Loanhead Colliery, Loanhead, - - 1878
Bell, Alan D., 123 St. Vincent Street, Glasgow, - - 1890
Benson, James R., West Longrigg, Airdrie, - - 1887
Beveridge, David, Kirkness Colliery, Lochgelly, - - 1888
Beveridge, James, Linlithgow Oil Coy., Linlithgow, - 1882

* Deceased.

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Beveridge, John, Kelty Colliery, Blairadam, - - 1881
Birrell, George, 2 Havelock Terrace, Paisley Road, Glasgow, - - - - - - 1880
Blackwood, James, Albany Place, Hamilton *(Librarian)*, - 1887
Blyth, Archibald, Bent Colliery, Hamilton *(Treasurer)*, - 1878
Bowie, Hunter, Lugar Iron Works, Old Cumnock, - 1881
Brand, Mark, Faulds Park, Baillieston, - - - 1890
Brown, George, Longriggend Colliery, Airdrie, - - 1880
Brown, John, Doura, Irvine, - - - - 1888
Brown, Robert, Croftview, East Kilbride, - - 1883
Brownlie, Archibald, Lassodie Colliery, Dunfermline, - 1883
Bryden, David, Coylton, Ayr, - - - - 1881
Buchanan, John, Palacecraig Colliery, Airdrie, - - 1887
Burt, Hutchison, Gilmerton Colliery, Gilmerton, - - 1885

Caldwell, James, Pumpherston, Mid-Calder, - - 1887
Campbell, Alexander, Bellfield Colliery, Hurlford, - 1882
Campbell, James, Burnside Row, Auchinleck, - - 1889
Campbell, John, - - - - - - - 1888
Campbell, Thomas, Spindleside Colliery, Omoa, Motherwell, - - - - - - 1881
Campbell, Thos. B. 123 St. Vincent Street, Glasgow, - 1890
Carey, William, Grange Colliery, Bo'ness, - - - 1882
Carmichael, Robert, Earnock Colliery, Hamilton, - - 1880
Clark, John, Arniston Colliery, Gorebridge, - - 1888
Clark, William, 208 St. Vincent Street, Glasgow, - - 1883
Clarke, J. A., Ayr Colliery, Ayr, - - - - 1880
Clelland, James, Carronhall Colliery, Falkirk, - - 1879
Cochrane, Joseph, Tippiecanoe, Fayette Co., Pa., U.S.A., - 1883

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Cochrane, Neil, Glasgow Canadian Phosphates Co. (Ltd.), Buckingham, Ottawa, Canada, - - - 1881
Cowan, James, Cadzow Colliery, Hamilton, - - 1885
Cranston, David, Woodend Colliery, Armadale, - - 1880
Crichton, A. H., Hillside, Linlithgow, - - - 1880
Crockett, John D., Curran House, Dungannon, - - 1880
Crookston, Andrew, Wemyss Colliery, Dysart, Fife, - 1880
Crookston, Thomas, Meiklehill Colliery, Kirkintilloch, - 1879
Cunninghame, Archibald, Eglinton, Iron Co., Dalry, - 1881
Cuthbert, Robert, - - - - - 1881

Danks, Henry, Green Colliery, Wishaw, - - - 1880
Dewar, Thomas, Glencleland Colliery, Wishaw, - - 1881
Dick, James, Drumsmudden Colliery, Drongan, - - 1889
*Drinnan, John, Wishaw Coal Coy., Motherwell, - - 1880
Drinnan, Walter, Macate Mining Coy, Chimbote, Peru, - 1888
Dron, Robert W., 79 West Regent Street, Glasgow, - 1888
Dunn, Robert, Kennedies, Hamilton, - - - 1890
Dunsire, Andrew, Cameron Colliery, Windygates,- - 1883

Easton, Alexander, 13 Southbridge Street, Bathgate, - 1883
Easton, Alexander, Hope House, Cleator Moor, Cumberland, - - - - - - 1888

Faulds, Alexander, Melbourne Villa, Cambuslang (*Councillor*), - - - - - - 1878
Ferguson, David, 124 New City Road, Glasgow, - - 1878
Ferguson, Duncan, Lochore and Capeldrae Collieries, Lochgelly, - - - - - - 1880

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* Deceased.

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Ferguson, William, Byrehill Row, Kilwinning, - - 1887
Findlay, Hugh, 78 Hill Street, Kilmarnock, - - 1886
Fisher, Robert, Bowthorn Colliery, Cleator Moor, Cumberland, - - - - - - 1888
Forbes, Alexander, Allanton Colliery, Hamilton, - - 1885
Foster, John W., 24 Silksworth Terrace, New Silksworth, Sunderland, - - - - - 1889
French, John, Millcroft Cottage, Rutherglen Road, Glasgow, 1879
Frew, James, 5 Greenhill, Waterside, Ayr, - - 1887
Frew, William, Shields Colliery, Motherwell, - - 1887

Gardner, Hugh, 160 Hope Street, Glasgow, - - 1890
Gavin, James, Udston Colliery, Hamilton, - - 1880
Gibb, Robert, Daldowie Colliery, Broomhouse, - - 1887
Gibson, William K., Craigbank, New Cumnock, - - 1886
Gilchrist, James, St. Helens Colliery, Workington (*Vice-President*), - - - - - - 1878
Gilchrist, John, 2 Old Terrace, Muirkirk, - - - 1888
Gillespie, Alexander, Dalmellington Iron Works, Ayr, - 1889
Gilmour, James, Duchray Colliery, Coylton, Ayr, - - 1881
Goodwin, George, Blackhill Colliery, Maryhill, - - 1885
Goodwin, Thomas, Newton Colliery, Newton, - - 1891
Graham, Hugh, Shotts Iron Works, Shotts, - - 1888
Grant, John, Bog and Home Farm Collieries, Larkhall, - 1878
Gray, David, Chapel Colliery, Newmains, - - - 1885
Gray, John, Morningside Colliery, Newmains, - - 1885
Gray, William, Common Cottage, Auchinleck, - - 1880
Gray, William, Carfin Colliery (Dixon's), Motherwell, - 1885
Green, William, Galston Colliery, Galston, - - 1883

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Greig, James, Arden Works, Airdrie, - - - 1887

Haddow, John, Arniston Colliery, Gorebridge, - - 1879
Hamilton, James, 208 St. Vincent Street, Glasgow, (*Councillor*), - - - - - - 1883
Hamilton, John, 10 Brown Street, Hamilton, - - 1890
Hamilton, John P., 34 Cadogan Terrace, S.W., London, - 1888
Hamilton, William, Westburn Colliery, Newton, - - 1888
Hardie, James, Hopetoun, Winchburgh, - - - 1882
Hart, John, Clyde Iron Works, Tollcross, - - - 1881
Henderson, Andrew, Gartsherrie Colliery, Coatbridge, - 1880
Henderson, William, Levenseat, Fauldhouse, - - 1884
Hendrie, James, 6 West Benhar, Whitburn, - - 1890
Herd, Samuel, Balgonie, Markinch, - - - 1885
Herd, Thomas, Dunnikier Colliery, Kirkcaldy, - - 1880
Heron, James, Auldhouseburn Colliery, Muirkirk, - 1888
Hill, James, Dalmellington, - - - - 1880
Hillhouse, William, Bonnyton Cottage, Kilmarnock, - 1883
Hogg, James, Kirkhill Colliery, Cambuslang, - - 1887
Hogg, William, Carnmoor Cottage, Forth, by Lanark, - 1881
Howat, John T., Eglinton Iron Works, Kilwinning, - 1883
Howat, Robert M., Bardykes Colliery, Newton, - - 1886
Howat, William, Morningside Colliery, Newmains, - 1886
Howat, William, Southrigg Colliery, Armadale, - - 1886
Hunter, Adam, Braidenhill Colliery, Airdrie, - - 1885
Hunter, A., Alloa Colliery, Alloa, - - - - 1880
Husband, John, Tannochside, Uddingston, - 1881

Ireland, Thomas, Largoward, St. Andrews, - - 1881

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Jackson, Douglas, Coltness Iron Works, Newmains, (*Councillor*), - - - - - - 1880
James, William, Fordell Colliery, Crossgates, Fife, - 1883
Jamieson, Alexander, Balgonie Colliery, Markinch, - 1878
Jamieson, William, Mining Office, Broxburn, - - 1879
Jeffrey, William, Ladylands Colliery, Shotts, - - 1888
Johnstone, William, Coaltown of Wemyss, E. Wemyss, - 1888

Kennedy, Alexander, Broxburn Oil Works, Broxburn, - 1882
Kennedy, William, Whiteside Lane Cottage, Bathgate, - 1888
Kerr, Archibald, Crowhills, Lesmahagow, - - 1881
Kerr, Thomas, - - - - - 1888
Kerr, William, - - - - - - 1885
King, Henry, Darngavil Colliery, Airdrie, - - 1889
Kirkwood, William, Blackstone Works, Paisley, - - 1880
Kirkwood, Wm. A., Clydeview, Larkhall, - - 1890
Knox, James, Tranent Collieries, Tranent, - 1880

Lander, Francis, Holmes Cottages, Uphall, - - 1885
Legat, A. S., 26 N. Hamilton Street, Kilmarnock, - 1879
Leggate, Robert, High Shawsburn, Larkhall, - - 1890
Lindsay, Thomas J., Castlehill Iron Works, Carluke, - 1885
Lithgow, Thomas, Langbyres Colliery, Omoa, Motherwell, 1882
Little, William, Gateside Colliery, Cambuslang, - - 1890
Livingstone, Archibald, Millburn Cottage, Deans, Bathgate, 1880
Love, John, Shottstown, Penicuik, - - - 1878
Love, John, Portland Iron Works, Hurlford, - - 1882
Love, William J., - - - - - - 1881

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*M'Beth, Peter, Callander Coal Co., Falkirk, - -	1879
M'Bride, John, South Lodge, Rawyards, Airdrie, - -	1889
M'Cann, Edward, 9 Westpans, Musselburgh, - -	1888
M'Culloch, John, Jawcraig Colliery, Slamannan, - -	1888
M'Culloch, William, Linkieburn House, Muirkirk, -	1881
M'Donald, John, Greenhill Colliery, Holytown, - -	1880
M'Donald, John, jr., Greenhill Colliery, Holytown, -	1890
Macfarlane, Nigel, Blantyre, - - - -	1890
M'Farlane, Walter, Mossvale Cottage, Chryston, - -	1882
M'Gee, John, Tillicoultry Colliery, Tillicoultry, - -	1880
M'Gill, James, Burntisland Oil Works, Burntisland, -	1887
M'Kay, James, Roughrigg Colliery, Airdrie, - -	1880
M'Neil, James, Glencleland House, Wishaw, - -	1878
M'Phail, James, North Motherwell Colliery, Motherwell, -	1884
M'Pherson, Gilbert, Holmes Colliery, Galston, - -	1881
Malcolm, James, Haywood Colliery, Lanark, - -	1879
Marshall, John, Seymour House, Stevenston, Ayrshire, -	1888
Martin, Robert, Niddrie Collieries, Portobello, - -	1879
Martin, William, Douglas Park Colliery, Bellshill, -	1881
Meikle, Hugh, Ayr Colliery, Annbank, - - -	1890
Menzies, John, Auchinraith Colliery, Blantyre, - -	1889
Middleton, George, Neilston Colliery, Kilsyth, - -	1886
Miller, John D., Langloan Iron Works, Coatbridge, -	1888
Miller, Robert, - - - - - -	1890
Milligan, Peter, Cleland, - - - - -	1884
Moffat, James, - - - - - -	1888

* Deceased.

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Moodie, Thomas, Earnock Colliery, Hamilton, - - 1881
Moore, Robert, Pumpherston, Mid-Calder, - - 1888
Morton, John, 8 Garden Street, Galston, - - - 1880
Morton, R. M., Ansonhill House, Crossgates, Fife, - 1879
Morton, William S., Skaterigg Colliery, Maryhill, - 1884
Mowat, David M., Summerlee Ironworks, Coatbridge, (*Councillor*), - - - - - 1886
Muir, Robert, Bog Colliery, Larkhall, - - 1887
Muir, Robert, Hill of Beath Colliery, Crossgates, - 1890
Muir, W. W., Halbeath Colliery, Dunfermline, - - 1878
Munro, James, Quarter Collieries, Hamilton, - - 1879
Munro, Neil, Twechar, Kilsyth, - - - - 1886

Napier, James, 16 Whitevale Street, Glasgow, - - 1890
Nasmyth, A., Donibristle Colliery, Crossgates, Fife, - 1880
Neilson, Benjamin, Prestongrange Coal Coy., Prestonpans,- 1880
Ness, Henry, Muircockhall Colliery, Dunfermline, - 1880
Nimmo, Thomas, Kinneil Colliery, Bo'ness, - - 1879
Nisbet, Andrew, Carfin Colliery, Motherwell, - - 1884
Nisbet, Henry, Devon Colliery, Alloa, - - - 1888
Nivison, John, Dykehead Colliery, Larkhall, - - 1886

Orr, Thomas, Bredisholm Colliery, Uddingston, - - 1881

Park, James, Wellhouse, Rutherglen, - - - 1883
Park, Joseph, Allanshaw Colliery, Hamilton, - - 1878
Parker, William, Woodville Cottages, Armadale, - - 1887
Paterson, Hugh, Braidhurst Colliery, Motherwell, - 1881
Paterson, Peter, 1 Cambusnethan Street, Wishaw, - 1889

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Paterson, Thomas, 208 St. Vincent Street, Glasgow, - 1883
Paul, James, 84 Albany Place, Hamilton, - - 1881
Pearson, Andrew, Ross Colliery, Hamilton, - - 1889
Peddie, J. F., 15 Oxnam Crescent, Newcastle-on-Tyne, - 1889
Penman, James, Leven Collieries, Leven, - - - 1883
Prentice, Wm. P., Dalmeny Works, Dalmeny, - - 1889

Plunket, Edmund, Bishopbriggs, Glasgow, - - 1889
Potts, Samuel, Greenfield Foundry, Hamilton, - - 1888
Prentice, James, Stanrigg Collieries, Airdrie (*Councillor*), - 1881
Prentice, Thomas, Brisdanehill, Wes Calder, - - 1879

Rankin, George, Victoria Works, Nitshill, Hurlet, - 1889
Rennie, Wilson, Gateside Colliery, Cambuslang, - - 1890
Ritchie, James, Gartness Colliery, Airdrie, - - 1885
Roberts, James, Gilbertfield Colliery, Cambuslang, - 1889
Robertson, Alex., Benwhat, Dalmellington, - - 1880
Robertson, Archd., Bathville Colliery, Armadale, - - 1880
Robertson, David, Drumbuie House, Beith, - - 1881
Robertson, George, Springfield, Blantyre, - - 1890
Robertson, James A., 54 Blacket Place, Edinburgh, - 1885
Robertson, John, Lanemark Colliery, New Cumnock, - 1880
Robertson, Richard, Rhins House, Baillieston, - - 1888
* Robertson, Thomas, New Lodge Slamannan, - - 1890
Robson, Robert, Sydney Mines, Cape Breton, Nova Scotia, 1882
Rodger, William, Fergushill Colliery, Irvine, - - 1888
Rome, J. E., Thistle Cottage, Longridge, Fauldhouse, - 1886
Rorison, John, Springhill Colliery, Kilmarnock, - - 1883

* Deceased.

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Ross, John, Dalquharran Colliery, Maybole, - - 1890
Ross, Michael, Dechmont Colliery, Newton (*Councillor*), - 1878
Rowan, Donald, Harthill, Whitburn, - - - 1884
Rowan, Henry, Hill of Beath Colliery, Crossgates, - 1881
Roy, Henry, Legbrannock Collieries, Holytown, - - 1889
Roy, John, Fireclay Works, Castlecary Station, - - 1888
Roy, Robert P., Mount Carron, Larbert, - - - 1889
Russell, Andrew, 97 Melville Drive, Motherwell, - - 1887
Russell, Charles, - - - - - - 1886
Russell, Joseph, Daldowie Colliery, Broomhouse, - - 1889
Russell, W. S., Newliston Works, Kirkliston, - - 1880

Salmond, James, Barncluith Colliery, Hamilton, - - 1888
Scobie, William, - - - - - - 1881
Scott, John, Calder Iron Works, Coatbridge, - - 1879
Seggie, Robert, Inkermann Works, Paisley, - - 1890
Sharpe, George, Shotts Iron Works, Shotts, - - 1881
Shore, William M., Kaitangata, Dunedin, New Zealand, - 1886
Simmons, John, Bardykes Colliery, Newton, - - 1890
Simpson, Alexander, Knockterra Cottage, Cumnock, - 1889
Simpson, Dundas, Ellismuir Colliery, Baillieston, - - 1879
Simpson, Robert, Auchter House, Newmains, - - 1888
Smith, David, Dalmellington Iron Works, Ayr, - - 1885
Smith, David L., Barkip Works, Dalry, - - - 1888
Smith, Hamilton, Cadzow Colliery, Hamilton, - - 1878
Smith, James, Hallhill Colliery, Baillieston, - - 1881
Smith, John, Cannock Lodge Colliery, Bloxwich, Staffordshire, - - - - - 1878
Smith, John, Rosehall Colliery, Coatbridge, - - 1880

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Sneddon, James B., Oakbank Colliery, Mid Calder, - 1886
Speir, William, Balgonie Colliery, Thornton, - - 1888
Speirs, Adam, Westmains Cottage, Bathgate, - - 1888
Stark, Archibald, Orchardhead Cottage, High Blantyre, - 1888
Stevenson, Wm., Aitken's Buildings, Rawyards, Airdrie, - 1888
Stevenson, Henry, Portland Collieries, Alfreton, Derbyshire, - - - - - - 1890
Stewart, H., Muiravonside Colliery, Slamannan, - - 1881
Stewart, Robert, Legbrannock Collieries, Holytown, - 1883
Stirling, John, Bonnybridge, - - - - 1880
Stoker, Thomas E., 16 Institute Terrace, Peases West, Crook, R.S.D., - - - - - 1890

Telfer, Henry, Overtown Colliery, Wishaw, - - 1878
Thom, Archibald, Moresby Coal Coy., Whitehaven, - 1881
Thom, James R., Bothwell Collieries, Bothwell, - - 1887
Thomson, A. M'D., Raith Colliery, Cowdenbeath,- - 1880
Thomson, George, Fauldhouse Works, Fauldhouse, - 1884
Thomson, James, Ross Street, Dunfermline, - - 1883
Thomson, John, Lumphinnans Colliery, Cowdenbeath, - 1888
Thomson, Richard, Queen's Buildings, Lenzie, - - 1878
Thomson, Thomas, Balquhatstone Cottage, Slamannan, - 1879
Turner, William, Chapel Colliery, Newmains, - - 1881
Twaddle, William, Ferniegair, Hamilton, - - - 1878

Waddell, Alexander W., 37 Burnbank Gardens, Glasgow, 1883
Waldie, A. B., 25 Douglas Crescent, Edinburgh, - - 1885
Walker, David, jun., Bathville Collieries, Armadale, - 1884
Walker, George B., Tankersley Grange, Barnsley, - 1887

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Walker, Robert, Bog Colliery, Larkhall, - -
Walker, William, Cadzow Colliery, Hamilton, - -
Walker, William, Rigside Colliery, Douglas, - -
Walker, John W., Woodmuir Colliery, West Calder, -
Wardlaw, John, Stanley Cottage, Newmains, - -
Wardlaw, Robert, Crofthead Colliery, Fauldhouse, -
Wardrope, James, Fordell Colliery, Crossgates, Fife, -
Watson, Andrew, Cadzow Colliery, Hamilton, - -
Watt, Robert, Barncluith Colliery, Hamilton, - -
Watt, Robert, Craigend Cottage, Polmont Station, -
Webster, David, Burdiehouse Limeworks, Edinburgh, -
*Weir, Robert, Seaview Cottage, Grangemouth, - -
White, James, Westrigg Colliery, Armadale, - -
White, William, Burntbroom Colliery Broomhouse, -
Whiteside, John, Ballochmyle Colliery, Auchinleck, -
Wilkie, William, South Arnloss Colliery, Slamannan, -
Williams, W. H., Shag Point Colliery, Shag Point, Otago, N.Z., - - - - - - 1
Williamson, James, Dunbeth Terrace, Coatbridge, - 1
Williamson, William, 41 Campbell Street, Hamilton, - 1
Wilson, Robert, Longrigg Colliery, Slamannan, - - 1
Wilson, Robert, Clydesdale Colliery, Wishaw, - - 1
*Wilson, William, Auchinraith Colliery, High Blantyre, - 1
Wingate, John B., 208 St. Vincent Street, Glasgow, - 1
Wood, Thomas, Addiewell Works, West Calder, - - 1
Wylie, James, Townhill Colliery, Dunfermline, - - 1
Wyper, James, Townlands Colliery, Hamilton, - - 1

* Deceased.

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NOTES ON PAPERS IN TRANSACTIONS OF KINDRED SOCIETIES.

Transactions of the MIDLAND INSTITUTE of ENGINEERS.

ARTIFICIAL FOUNDATIONS AND METHOD OF SINKING THROUGH QUICKSAND.

By W. E. GARFORTH. Vol. XI., p. 407.

THE depth of sand to be sunk through was about 18 feet, and it was wet from the surface throughout. The object was to sink the tubbing to the solid metals on which the sand rested without withdrawing the water, so as to avoid subsidence of the various surface erections. Supports for the balks of timber for lowering screws were erected of sleepers in the form of chocks. On these chocks two trussed logs, each 17ins. square and 53ft. long, rested. Four transverse beams, 14 inches square, set in pairs, rested on the main balks, and to these were attached the lowering screws, 3ins. diameter, and four in number, which controlled the descent of the tubbing. The water in the pit served as a guide to show any deviation of the tubbing from the vertical. If such occurred, it was rectified by manipulation of the screws. When the friction arrested the descent of the tubbing, an excavation was made round the sides, and the sand therefrom thrown to the centre of the pit. When the bottom of the quicksand was reached, the water was pumped out, the cutting edge of the tubbing was rested on wall plates, and the sinking continued through the water-bearing strata, the bottom of which was reached at 54 yards deep. The water was then tubbed back by a cement lining 3ins. thick behind brick walling. While sinking through water-bearing strata, the water was pumped by two pulsometer pumps suspended in the shaft. The feeders of water gave off more than 1000 gallons per minute. Boiler foundations were formed first of concrete, 7ft. thick, put on in layers, 15ins. thick, on a bed of old sleepers. On the top of the concrete, rails of 70 lbs. per yard were laid longitudinally and transversely, 4ft. 3ins. apart, and the ends of the rails bent alternately upward and downward, so as to embrace the concrete and stonework above and below. On the top of the concrete was built a layer of stone in blocks, 6ft. × 4ft. 6ins. × 6ins. The concrete and stonework were embraced by iron rails round and round horizontally, and so bound together as to form a foundation of uniform support. On this foundation was built the brick

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boiler seating, with air passages above the stonework, with the object of preventing heating of the concrete and destruction of the cement. The engine-houses and workshops were built on beds of concrete, 6ft. thick. No evidence of unequal settlement was observed.

The results of a few tests of the strength of pit props are appended, showing very great variations in strength of trees of exactly the same size and length. Props 6ins. in diameter and 6ft. long supported pressures varying from 19 to 61½ tons, while chocks of elm, formed of pieces 24ins. × 6ins. × 6ins., collapsed under strains of from 43 tons to 60 tons.

There is also a short description of a method of sinking pillars through sand in use at Calais Harbour Works. In forming dock walls there, the plan followed was to sink pillars in the sand by excavating the sand with water jets, and pumping it out suspended in the water. The pillars, 26ft. square, of rubble masonry, set in cement, were built with an octagonal hole, 8ft. diameter, in the centre, the bottom of which tapered outward, and formed a kind of cutting edge. The pillars were built to such a height as was necessary to sink them—about 12ft., to begin with—and when cement was set, sinking began. Jets of water, under pressure from flexible pipes carried down each angle of the octagonal central opening, were directed against the sand under the edge of the pillar, care being taken so to direct the jets of water as to keep the pillar sinking vertically. A centrifugal pump raised the water again to the surface, and with it the sand in suspension. J. H.

JOURNAL OF THE BRITISH SOCIETY OF MINING STUDENTS.

NOTES ON KŒPE SYSTEM OF WINDING.

Vol. XI.—p. 177.

THE Kœpe System of winding does not appear to work quite satisfactorily in a few instances of its application in this country. The friction of a half turn on the driving drum or pulley varies according to the condition of the winding rope, so that after oiling the rope it may not grip sufficiently, but slip and cause great inconvenience in landing cages at top and bottom of shafts. In two cases the system has been adopted and abandoned in Germany for reasons not stated. It has also been disused at Bestwood Colliery, principally because of the difficulty caused by slipping, but it continues to give satisfaction at Sneyd Colliery, North Staffordshire. J. H.

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Transactions of the MIDLAND INSTITUTE of ENGINEERS.

AN OUTBURST OF GAS AT THE MONK BRETTON COLLIERY, NEAR BARNSLEY.

By J. L. MARSHALL. P. 22.

THE night deputy, who made his examination of the workings between three and five o'clock in the morning, found all the places free of gas, and observed nothing unusual except that two drifts in his district were "on the weight." These he fenced off, and returned to examine them after completing his rounds. Passing along the main intake air-way, he was stopped by gas which had made its way outwards against the current a distance of 40 yards from the places he had before observed "on the weight," whence, as was afterwards discovered, the gas was coming. When he had cleared the gas sufficiently, he found that about 20 yards of the pavement, over a width of 12ft., had been raised from 2ft. to 2ft. 6ins. high, and that gas was issuing from a crack on the top of it. It took 24 hours afterwards to clear the gas out of the ventilating district which is in close proximity to the Oaks Colliery, where there was a great feeder of gas, that was utilised in lighting the pit bottom.

J. H.

THE ENGINEERING AND MINING JOURNAL.

A PROPOSED NEW METHOD OF MINING ANTHRACITE.

By W. S. Gresley. Vol. XLVIII.—p. 136.

THE existing methods of working the Anthracite seams of Pennsylvania are admittedly very wasteful; from 40 to 50 per cent. or even more of the coal being left in the workings. The loss, it is argued, might be greatly reduced, at least in seams lying at a moderate inclination, by adopting what is termed by the author "Longwall Limited." The principal bed in the Anthracite region is the Mammoth seam of great thickness, and split up into numerous bands by seams of shale of varying thickness. To such conditions, or to seams lying at short distances apart, the proposed method is held to be suitable. It is what is known as "Longwall withdrawing" with each section of working of very moderate extent, and each having an engine dook or slope for hauling the coal from it alone. The dook having been driven in the under seam or bed to the lowest level it is proposed to work, the workings are opened out on each side for a distance of about 500 feet in each seam, the upper seams being opened off a level cross cut driven to dip in line of slope. There are then as many parallel faces of coal as there are seams, and at distances apart determined by the thickness of strata between and the inclination thereof. Work then goes on simultaneously in all the seams towards the rise. The roof is supported in the ordinary way by timber and stone

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buildings, so far only as necessary to preserve the roadway which runs along level course close to the solid coal. As each face advances the roadway as required is lifted and re-laid again close to the face. The roof of the cross cut is at the same time blown down, and the road re-laid at the new level. Thus all shoots, manways, inclines, and carriage braes are done away, and the whole of the coal is raised by the hauling engines, directly from the level at which it is mined. This system has been applied in Warwickshire, in the "Staffordshire Thick Coal," and the loss of coal there is said to have been 12·5 per cent. Obviously the method suits best, if it does not absolutely demand, conditions wherein sufficient stowage is at hand to completely fill the waste. Given such conditions the problem of mining thick seams is comparatively simple, and the choice of methods is less limited. J. H.

PAMPHLET by F. J. ROWAN.

ON FLAME.

This paper is reprinted here from "The Journal of the Society of Chemical Industry," and is a summary of the present state of knowledge of flame under the several heads of: its nature—temperature and rate of propagation—and luminosity. Under the second head there is an interesting illustration of how far inferences drawn from laboratory experiments may lead astray when the limits within which they are applicable are not carefully observed. One experimenter found the maximum rapidity of inflammation of marsh gas and air to be about 20 inches per second. Were such results true, when applied on the full size scale of a mine, a fire damp explosion would not be such a formidable thing as it is. These experiments give results when ignition takes place at constant pressure and are not applicable to cases where inflammation is produced at constant volume or nearly so. It would also appear that the rate of ignition is dependent upon the amount of mechanical disturbance accompanying it, and not on the proportions of gas and air in the ignited mixture. Another observer points out that when flame travels at a velocity greater than 4¼ft. per second it will pass through the gauze of a safety lamp, and that a flame once started in a confined space may, by the disturbance it causes, propagate itself very rapidly indeed in the remainder of the inflammable atmosphere. "A definite explosive mixture may have a velocity of propagation of flame as low as 1½ft. per second" in an unagitated mixture, but when it becomes agitated to a certain degree it may have a rate of propagation of several thousand feet per second. J. H.

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PAMPHLET by F. J. ROWAN.

NOTES ON CHIMNEY DRAUGHT AND FORCED COMBUSTION.

THIS is a reprint from the Transactions of the Institution of Engineers and Shipbuilders in Scotland. At the outset a recapitulation of Rankine's formulæ for chimney draught is given, leading up to a consideration of the relative economy of chimney and forced draught. With a given external temperature, there is a corresponding temperature of the escaping gases which gives the most effective chimney draught. Relatively these are as 12 to 25 when the temperatures are absolute, that is taken from the absolute zero—461° Fah. Practically, the temperature of the hot gases should be slightly under the temperature of melting lead. Taking the necessary air supply to the furnace at 24lbs. of air per lb. of fuel, some idea is conveyed of the very large waste of heat continually going on with chimney draught. The principle of "forced combustion" begins to find favour. With mechanical power supplying air to boiler furnaces, a higher temperature of combustion is secured, and consequently higher evaporative effect, and that in a higher ratio than is due merely to increase of fuel consumed. In one case the evaporative power of a boiler was increased from 1552 to 2454 lbs. of water evaporated per hour, while the relative evaporative effects were 7·21 lbs. and 9·26 lbs. of water per lb. of fuel. With forced draught the higher temperature of combustion does not necessitate a higher temperature of the escaping gases, for the passage of the heated gases is better under control, and they can thus be made to give up more of their heat before escaping than is possible with chimney draught. Péclet experimented with forced combustion and gives two cases where a 6 horse-power engine produced by means of a ventilator draught equal to what required equivalent to 50 horse power by means of a chimney. As to the method by which forced combustion is produced, it would appear that to do so by increasing the pressure at the furnace is preferable as giving easier control of the heated gases, so that they yield up their heat more completely. It also has some possibilities of increased economy by supplying air at pressure above atmospheric pressure. If combustion were carried on under pressure, then the loss of heat by expansion of air would be decreased. This benefit of high pressure combustion is shown by the statement that the temperature to be expected in a furnace working under pressure of two atmospheres "will be the same as if the products obtained by combustion under atmospheric pressure were, before becoming at all cooled, suddenly compressed to half their volume."

J. H.

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EXTRACTS FROM REPORTS OF THE INSPECTORS OF MINES FOR 1889.

Mr J. B. ATKINSON, East Scotland District.

Falls of roof and side.—Twenty-two persons were killed by falls of roof, and eight by falls of side. These accidents were all of the usual character; this most prolific source of loss of life in mines can only be lessened by the increased application of precautions that are perfectly well understood, and are provided for by the general and special rules.

Opinion as to the influence of coal dust in colliery explosions, and means of averting its effects, is in a somewhat unsatisfactory state, and I think the question will have to be further considered. Parliament has taken upon itself the responsibility of inquiring into the causes of loss of life in mines, and this has, I think, in some degree prevented the investigations being pursued by the owners of mines, who are not ready to call attention to a danger when the providing of remedies is taken out of their hands and made statutory by Parliament. It is, therefore, all the more necessary that the investigation of this subject by the Legislature should be thorough. The conclusions of the last Royal Commission on Accidents in Mines on the influence of coal dust in explosions were not founded on the experimental basis the question demands. Although this country suffers most from explosions in mines, the most searching experimental investigation into the influence of coal dust in explosions has been made by the Germans, and even there the scale on which the experiments were conducted was too restricted.

At the conclusion of his report on the Mauricewood Pit disaster, Mr Atkinson states :—

I am of opinion that the Mauricewood and Greenlaw shafts, and the communication road between them, satisfied the requirements of section 16, and while there were, in this case, two available roads from the 160 fathom level, this double communication in the seam worked is not statutory.

I may say, however, that the miners and many mine managers have viewed this section as having a much more extended application than the above, and, in any future Act, I think that the application should be extended by providing that, in any district of a mine where more than a specified number of persons are employed at one time, there shall be at least two roads of a specified size to the surface, separated at all parts by a specified distance, and such roads shall be available for ingress and egress, and shall be regularly examined and reported upon by a competent person.

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This accident shows the danger that may arise in steep workings from a fire in the return air way, accompanied by short circuiting of the air, owing to the changes in the direction of pressure and flow of air that may result.

The precautions suggested are :—

1st. The prevention of fire, particularly where the heat from steam pipes in a return air way causes unusual dryness.

2nd. The separation of the intake and return air ways so as to avoid short circuiting of air.

3rd. Means to prevent air flowing from the return to the intake air way where these roads are highly inclined.

This latter object may be attained by having no communication between such intake and return air ways, except openings completely closed by snecked doors, but, having in view the extreme rarity of the accident and the serious inconvenience that would in many cases be caused by following such a rule, I am not inclined to recommend it as a practical remedy.

Mr J. M. RONALDSON, West Scotland District.

THE non-fatal accidents by falls number 87, 34 being by falls of coal, &c., and 53 by falls of roof, and, as too frequently happens, many of them, as well as the fatal accidents, were caused by the failure to secure the working place by props and sprags. The fatal accidents by falls formed 43½ per cent. of the deaths by all causes, and the non-fatal 40 per cent. of the injured. I have no reason to alter my repeatedly expressed opinion that until systematic compulsory propping and spragging are introduced, there is little hope of seeing much reduction in the number of these accidents, of which so many are preventable. In many mines a regular system of propping is carried out, but it consists of carefully setting props at some distance back from the coal face, and systematically abstaining from setting props close to the face. Common sense should teach miners and managers alike that the part of the roof beneath which the workmen are for the greater part of their shift employed is the part which needs most careful propping in order to prevent accidents, but unless where the roof is very tender and must be closely propped to keep it from falling, miners have a decided objection to set props at the working face, as this would interfere with their work.

A large number of the accidents by falls in "long-wall" workings take place at the road head, and the securing of this part of the working place should receive careful attention. Not only are the miners and drawers

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engaged for a longer time at this point than in any other during their shift, but also the roof being broken up by blasting, falls of roof at or close to the "brushing" face are more liable to occur.

Mid-workings are always a source of danger, and specially so when the fence consists of a gate or bars which may be left open when the cage is not there, either through the carelessness or inadvertence of the bottomer. Where it is necessary to have a mid-working with an open shaft beneath, a good arrangement is to put in "safety shuts," which act either as a vertical fence across the entrance to allow the cage to pass, or, when folded down, serve as a scaffold for the cage to rest upon. The shaft is thus constantly fenced, and by means of a wire connected with a lever which works the shuts, and carried into the engine-house to an indicator, the engineman always knows whether or not the shaft is clear for the cage to pass. Where such an appliance is not in use, I am of opinion that the fence should be connected by means of a signal wire to an indicator in the engine-house, and that instructions be given to the bottomer not to open the gate until the cage had arrived opposite him, and to the engineman not to move the cage until the indicator shows that the gate has been closed. Where there is only one mid-working a safer method is to have one cage going no farther than the mid-working where a fixed scaffold is placed across the shaft, but where it can be readily done I would recommend the coals all to be brought to one bottom by means of cross-cut mines from upper seams, thus avoiding the danger and trouble, and, in many cases, extra expense, of mid-workings.

Practically, in this district the workmen continue to take no advantage under General Rule 38 of the power conferred upon them to inspect the mines in which they work, either by two of their own number, or by other two practical miners. It rarely comes to my knowledge that such inspections are ever made.

Complaints.—As usual, a number of complaints by or on behalf of workmen, anonymously and otherwise, have been made during the year, and these have all been investigated with as little delay as other duties permitted. While many of them were well founded, others proved to be without foundation, or of such a vague nature that, upon investigation, no violation of the statute could be ascertained. A large proportion of the complaints dealt with the questions of weighing and the facilities to be afforded to checkweighers.

Mr THOMAS BELL, Durham District.

In addition to the three fatal accidents by explosives enumerated in the list, there have been no less than 47 cases of serious personal injury reported as having taken place from this cause during the year. In the

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majority of cases it could be traced to indifference to all rule, and carelessness in handling the explosives. A few accidents have occurred while using the higher explosives, such as blasting gelatine, roburite, and tonite, which are now being more generally used in place of gunpowder. These accidents have all been caused by the insufficient strength of the detonators, the workmen having until recently used what is termed No. 2 or 3 strength, whereas it ought not to have been less than No. 6. Since the makers of the explosives commenced to supply their customers with the proper detonators, I have heard of no missed shot or imperfectly exploded charge.

In no case was there any accident reported while charging a machine-drilled hole. The bore is perfectly smooth and uniform throughout, and there is no danger in charging from canches being left on, as is the case with hand-drilled holes. A large proportion of the Cleveland ironstone is mined by these drills, and they are also becoming extensively used in the coal mines, and are fast superseding the old-fashioned system of "jumper," and hammer and drill.

The appointment of under-manager has not met with the success I at one time anticipated.

There has not to my knowledge been a single additional appointment made to the original staff, the owners having simply appointed their under-viewers and overmen to the office, whose duty it has ever been to visit the underground workings daily, and consequently the "daily personal supervision" remains unaltered, with probably the exception that in some instances it has led to certain relaxation of underground supervision by the responsible manager, who appeases his conscience by stating that it is not necessary for him to go down the mine so frequently when he has a certificated under-manager (his overman) down every day.

I am afraid the wording of the 21st section of the Act, "in every mine "required by this Act to be under the control of a certificated manager, "daily personal supervision shall be exercised *either* by the manager *or* by "an under-manager nominated, &c.," is having a tendency, in large concerns especially, to employ a less number of first-class or responsible managers, and to rely too much on their overmen whom they have appointed as under-managers, and whose labours in the mine are already sufficiently onerous without having additional burdens cast upon them.

Wherever safety lamps are used, they are shielded so as to be safely carried against the ordinary current prevailing in the mine. Many of the old Davy lamps are still in use, but they are placed in a proper tin case with a strong glass fitted in the side and extending nearly two-thirds round, and are securely locked. The Davy is the one most generally used by the deputies in making their examinations, as it is contended that gas can be more easily detected with this than by any of the other lamps. A

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large number of the Marsaut and Mueseler lamps have been introduced in these mines lately, together with many thousands of the Donald lamp, which has become a great favourite among the miners in this district.

Mr FRANK N. WARDELL, Yorkshire and Lincolnshire District.

ERUPTIONS or outbursts of gas have from time to time continued to take place at collieries in the district, but explosions of considerable magnitude, and probably disastrous results, have, I am thankful to say, been avoided, owing to the exclusive use of safety lamps in a perfect condition, and an admirable system of discipline. These outbursts cannot be predicted, and are liable to occur in any class of workings. The only way of guarding against them is by being prepared for them, and one way, as I have said, of insuring this is by maintaining the strictest discipline, and by the avoidance of naked lights in any form, and the use of the best kind of safety lamps which scientific experiments and experience can determine. The best system of ventilation in the world, as I have so often stated, would be of no avail whatever under such circumstances without the adjunctive aid of safety lamps, and to allege, as some do, that safety lamps militate against good ventilation is, in my experience, utterly untenable. The collieries where safety lamps are in exclusive use will compare favourably, as regards sufficient ventilation, with those where open lights are allowed. With respect to the question of dust, it is one of a complicated nature, and about which there is still a variety of opinions; although it is generally admitted, I think, that, at any rate, the presence of dust may enormously aggravate and extend an explosion. As to the actual percentage of dust mixed with gas, or whether dust can, *per se*, cause an explosion, these are matters open to argument, but at any rate the present Act recognises the importance of the matter, and to some extent provides for the treatment of dusty mines. One accident only from explosion by fire-damp attended with fatal results during the year, in such a large district as this, is very satisfactory testimony to the care which has been exercised both by the managers and the workmen.

The objectionable habit of preceding horses and corves by drivers and hurriers still prevails to some extent, and is productive of many accidents and deaths. The rules distinctly forbid such being done, but it is no doubt extremely difficult at times to prevent this practice, the boys being to a great extent out of sight of those in authority, and apt to be careless as regards this salutary prohibition.

I am glad to say the spread of the St. John Ambulance Association continues, and classes exist generally throughout the district. It is

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impossible to over-estimate the value of the instruction thus afforded, and within my own personal experience by its means many accidents, which would otherwise have been serious, have been reduced to comparatively slight and trivial cases. The fact is hardly sufficiently understood and appreciated, it seems to me, that the medical staff of the country have so nobly come forward, and so unselfishly, and at considerable sacrifice of much time and patience, given their services to promote this good cause. If it were not for this, and the information thus acquired, of course the presence of ambulance material at collieries would be practically useless. I trust the association may continue to prosper, and meet with all the support it so heartily deserves.

Mr JOSEPH DICKINSON, Manchester and Ireland District.

THE managers, the miners, and all concerned deserve congratulation on this being the third year in succession during which not any fatal explosion of fire-damp occurred in the district, such results being hitherto quite unknown.

It was predicted that more accidents were likely to occur from falls of ground in the mines with an increased use of safety lamps, and now, whilst the miners have scarcely become accustomed to the change, this drawback is being undergone, nearly two-thirds of the whole of the fatal accidents being attributable to falls of roof and sides. It therefore behoves the miners, who themselves have the most control in the prevention of such accidents, to be more careful in observing the required precautions, and it is also requisite that those acting in the management should more strictly enforce the rules respecting spragging and propping the working places, and securing the roof and sides of roadways.

The number of safety lamps now in use in the district is 29,227, a double set being kept at some collieries. The number comprises 12 different kinds, of which 18,800 are the Marsaut, 5,555 the Mueseler, and 3,103 the Davy, including 1,449 of the improved Davy, 311 Jacks, and 56 Donalds, the others being given in the details.

High explosives for blasting are used in some of the fire-damp collieries, and with some of these explosives a fire-extinguishing compound is put with the stemming to prevent flame and sparks. The powerful detonators used for firing some of the explosives, such as Roburite, are found by experience to require great care in handling.

The number of automatic appliances for preventing overwinding have

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increased from 105 disconnecting apparatus with safety hooks, when enumerated in 1879, to 186 in 1889. Two of these are in Ireland, one in Sussex, and 183 in Lancashire. A few automatic appliances for shutting off steam and putting on the steam brake are also in use.

The number of automatic safety catches for arresting the load in shafts, in the event of breakage of rope or coupling chain, which are not obligatory under either Act, have diminished four since 1879, namely, from 184 sets to 180, the slight diminution being due to the increased number of wire-rope guides with which such catches have not been found so suitable as with wooden conductors. Nearly all the catches in use are on Owens's principle, which answers the purpose exceedingly well, and the patent right expired many years ago.

As a matter of information, I am enabled, through the courtesy of the colliery owners who, kindly responding to my request, have each given the information respecting their own collieries, to furnish the following list of the number and kinds of safety lamps now in use in the collieries of this district, some of the collieries having two sets of lamps, one set being in use whilst the other is being cleaned and trimmed.

Safety lamps in use in North and East Lancashire:—

Bainbridge,		2
Clanny, bonnetted,		677
Davy,	1,449	
Ditto, improved,	1,287	
Ditto, ditto, "Jack,"	311	
Ditto, ditto, Donald,	56	
		3,103
Evan Thomas,		50
Hall's deputy,		2
Hepplewhite Gray,		61
McKinless,		137
Marsaut,	18,538	
Ditto, altered from the Evan Thomas,	262	
		18,800
Mercier,		128
Mueseler,		5,555
Park Lane,		704
Wall's deputy,		8
Total,		29,227

The use of high explosives for blasting is increasing, but where powder is allowed many colliers prefer it as being more useful. The high explosives chiefly used now are roburite, tonite, and the Settle gelatine water cartridge. Trench's fire extinguishing compound, for preventing flame or

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sparks in shot-firing, is also in common use with tonite in some collieries. Tonite alone is found to give off very little flame, and with a stemming of the compound, in a long record of shots that I have gone over, no flame is recorded, whilst with powder so stemmed flame or sparks appear in the record of more than half the number of shots fired.

In my report last year, I called attention to the care requisite in using some of the detonators for firing the high explosives. Three accidents from this cause have since come under my notice, two being in houses, and one in a colliery in this district, which appears in this year's list of accidents, where a shot-lighter had a thumb and two fingers blown off as he was moving the wires of a cartridge which the electric battery had failed to explode. Detonators, especially of this kind, when they do not explode, have to be carefully picked out from amongst the coal, lest damage might be occasioned by explosion in firegrates. The one which blew the man's thumb and fingers off had been so obtained, and it was after trying to fire it by other means that the accident occurred.

Mr HENRY HALL, Liverpool District.

I HAVE long been convinced that fire-damp explosions could be avoided almost entirely by two or three simple enactments, couched in language that could not be misunderstood. Where the rules attempt to draw fine distinctions as to what conditions amount to danger and what do not, they tend rather to make explosions more frequent than otherwise. For instance, take the case of the presence of fire-damp. The present rules suggest that fire-damp may be present without there necessarily being danger; that is, that the quantity may be so small as to be immaterial, and thus allowing all kinds of persons to use their personal judgment in the matter, and hence the frequent mishaps. I can quite imagine a man who is anxious to fire a blast in a place where fire-damp is present saying, "Well, there's not much, and the rule says I may fire if it is not dangerous."

It is only a question of time, and a few more disastrous explosions, and then blasting with the pit full of men will be put an end to once for all, and open lights or unlocked safety lamps in seams where fire-damp has once been met with will be allowed no longer.

The practical difficulties which it is the custom to urge against hard and fast rules as suggested ought not to deter the taking of the only steps which will ever be effective, and especially as those difficulties are largely imaginary, and when thoroughly examined they all evolve themselves into a question of twopence or threepence a ton extra cost of raising the coal.

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I have to report hat fatalities from falls of roof and coal still continue very frequent and disastrous, 55 deaths being due to this cause during the year, being nearly 50 per cent. of the whole loss of life. There appears to be no favourable advance as regards this class of accident, either in this district or in the other mining districts of the kingdom. I stated last year that the remedy for this state of things seems to lie in one or other of the following directions, either the principal part of the timbering should be taken out of the hands of the miners and performed by skilled officials, as is the case in Durham and Northumberland, in which dictricts fatalities of the description referred to are not nearly so frequent, or, if the miners are to continue to do the work of timbering, then they should be compelled to do it systematically, that is, in accordance with a well considered rule laid down by the manager, specifying the extreme distance between proper supports for the roof. If the latter plan were adopted, the miners would then act under orders, and would thus be compelled to timber up to a certain standard of security, whether they liked it or not, or whether it interfered with the filling and sending up of an extra tub of coal or not, and more responsibility would rest upon the officials. a responsibility which under the present practice has all but disappeared, leaving the workman to shift for himself, so far as the most dangerous part of his occupation is concerned.

There is an improvement in the way the colliers sprag their coal whilst holing, which a few years ago was very lax ; and this improvement is due to the Act of Parliament being plain and imperative—that this precaution *shall be taken in all cases whether there is apparent danger or not.*

A very serious accident through suffocation by gases occurred at the Westminster Colliery, Wrexham, under the following circumstances. Some fire-damp was known to have collected in a part of the workings to the rise in one of the seams, on account of the airways getting closed by falls of roof, and three men were sent to cut an opening through, so as to clear the gas out, and it would appear that as soon as the opening was effected, either the gas rushed out suddenly and overpowered the men, or it passed out upon them slowly and insidiously poisoned them. The three men were found dead, having apparently died without a struggle to escape. The deadly nature of fire-damp when undiluted with air is not sufficiently appreciated by miners, and probably in this case the only danger the men feared would be the possibility of the gas exploding at their lamps. There did not appear to have been any want of precaution taken, two of the men who were selected to carry out the operation being under-officials, well acquainted with the methods of dealing with bodies of fire-damp.

The recommendations of the Royal Commission, which were embodied in the new Coal Mines Regulation Act, 1887, in reference to the intro-

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duction of improved safety lamps, have been carried out, and there are now very few ordinary Davy lamps being used. The new lamps are, I think, an improvement on those formerly used, but a perfectly secure miner's lamp has yet to be invented. The regulations as to lamps should have gone further, and forbidden more than one "lamp station" in any seam. Lamp keys and "lamp stations" carried into the workings, and often within the zone of danger, entails a foolish and unnecessary risk.

The new regulations dealing with coal dust in the mines are considered to be impracticable so far as keeping the workings damp by means of water is concerned, and in place of watering a non-inflammable explosive is used, but, if the recent view expressed by scientific men is correct, that coal dust is almost more to be dreaded than fire-damp, then the damping of all mines should be insisted upon, even in the absence of blasting.

An initial explosion of fire-damp may arise from other causes than blasting, and it is held that in a dusty dry mine an initial explosion of what would otherwise be a harmless quantity of fire-damp becomes an explosion traversing the whole of the roads and parts of the mine where dust is lodged. So far as this district is concerned, steps are seldom taken to damp the mines, some of which, on account of their great depths, are very dry and dusty. I believe this indisposition to water the mines arises principally from an unbelief in the statements set forth as to the danger arising from the presence of dry coal dust. It is always difficult, however strict the law may be on the subject, to get people to take a course in the practical utility of which they are unbelievers. Some further experiments should be undertaken by the Government to confirm or confute the views which have been advanced, and conclusively prove to managers and miners the amount of danger that really exists.

Mr ARTHUR H. STOKES, Midland District.

Safety lamps and eyesight.—It has occasionally been publicly stated that the introduction of safety lamps into mines is proving injurious to the miners' eyesight, and I find when discussing the use of safety lamps with miners' deputations the question of eyesight is frequently brought forward, but the point always appeared to me to be one of sentiment rather than of fact. In consequence of the flame being surrounded by a wire gauze the light yielded by a Davy lamp must necessarily be very weak, and is considerably below one-fifth of a standard candle in illuminating power. But safety lamps have been devised which furnish an excellent light. The Marsaut lamp, well trimmed, burning good vegetable oil, with a flat wick and corrugated wick tube, gives a light equal to seven-tenths (0·7) of a standard candle, or about three-and-a-half times the light of the Davy lamp.

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Until a comparatively recent period, a large number of mines were worked exclusively with Davy lamps, and there is a very great number of miners in the North of England and South Wales districts who have from their youth up worked with no other light than the Davy lamp. It would appear that if the outcry about injured eyesight is to be substantiated by cases of miners working with the modern safety lamps giving three-and-a-half times more light than the Davy lamp, then, *a fortiori*, there should be a much clearer case against the old Davy lamp, and we should find a large number of miners in the North of England and South Wales with seriously injured eyesight, due to working with the Davy lamp. I cannot find any statistics to support this theory, and although I admit that the Marsaut or similar glass lamp does not give the light of a candle, yet there is no comparison between the light given by the old Davy and its present rival. I trust that the advocates of the injured eyesight theory who have publicly condemned the use of safety lamps will give equal publicity to the facts upon which they base their opinion, and, if possible, compare the results to eyesight between miners who have all their mining life used the Davy lamp and those whose eyesight is stated to have been injured by a few years' use of the modern Marsaut or similar safety lamp.

It has been frequently said that the general introduction of safety lamps would largely increase the death rate from falls of roof and side, in consequence of men not being able to see the state of the roof and timbering. I have always thought that such contemplated increase was more imaginary than real, and the statistics of this district are clearly against an increased number of deaths from falls of roof and sides due to the use of safety lamps. To test such a question no one mine could be selected. I have, therefore, taken the work of every mine in my district, and in the following table given the number of tons raised per life lost in mines worked with naked lights and with safety lamps, and as there are mines working with safety lamps in all parts of the district, so also there will be various kinds of roof under both conditions.

Nearly one half of the coal raised in the Midland District is worked by the use of safety lamps.

TONS RAISED AND PERSONS EMPLOYED UNDERGROUND PER LIFE LOST FROM FALLS OF ROOF AND SIDE DURING THE YEAR 1889.

NAKED LIGHTS.		SAFETY LAMPS.	
Tons raised per Life Lost.	Persons employed Underground per Life lost.	Tons raised per Life lost.	Persons employed Underground per Life lost.
520,703	1,280	728,696	1,793

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Ambulances.—In this district there are now over 3000 mine officials and workmen who hold ambulance certificates of qualification to render first aid to the injured. This is a most satisfactory state of things, and one to be encouraged in every way.

In July last a number of ambulance classes met in Basford Park, near Nottingham, and were reviewed by Surgeon-Major George A. Hutton, member of the examining staff, St. John Ambulance Association. The Surgeon-Major, as reviewing officer, exercised the men in ambulance work, and congratulated them upon the creditable way in which they performed all the exercises.

The valuable work done by ambulance men in this district is unrecorded, but many cases of excellent work and alleviation of pain have come under my notice, which, if recorded, would be most gratifying to the officials of the St. John Association, and to the surgeons and colliery officials who have taken the trouble to form classes and instruct persons in the work of first aid to the injured.

I hope the day is not far distant when every manager and undermanager in my district will be qualified to render first aid to the injured, and that mining officials generally will endeavour to make themselves acquainted with the slight elementary knowledge required to enable them to pass the examination necessary for obtaining a certificate of qualification from the St. John Ambulance Association.

Managers.—I think it my duty to again point out to managers that the appointment of an under-manager does not imply that their visits to the underground workings of the mine may be less frequent, or that it will affect their personal responsibility under the Act. In a few cases I have had to complain of the manager's neglect to visit the mine, and of the long interval between his inspections of the men's working places.

The manager of a mine should by frequent personal inspection of the underground workings make himself acquainted with every part of the mine, and by his position, authority, and skill maintain discipline and direct his officials in matters necessary for the safety and welfare of the miners and the mine. It is no less the duty of a manager to visit the under-ground workings now that an under-manager is appointed than it was before such an official was created.

Mr W. N. ATKINSON, North Staffordshire District.

It may not be out of place here to say a word of warning to persons who, without experience of large explosions, are called upon to enter a mine after an explosion has taken place. They should bear in mind that the resulting after-damp is of an extremely poisonous nature, *and that it may*

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be fatal to men when its presence cannot be detected by the lamps, or directly by any of the senses. It frequently occurs that men proceed into the workings before the ventilation is restored, and are not aware of the poisonous nature of the atmosphere until they are so far overcome as to be hardly able to retrace their steps into purer air, and sometimes they perish. It is probably carbonic oxide which poisons them. A minute proportion of this gas in the air is fatal to animal life. It is invisible, and has very little odour. The lamp, on which the miner chiefly depends for information as to the state of the air, is useless to warn him that carbonic oxide is present even when in such proportion as to be rapidly fatal.

This disaster (Mossfields Colliery explosion) is another example of how an explosion is extended by coal dust, and the loss of life greatly increased in consequence. The normal condition of a dry and dusty colliery or of a colliery in which the roads connecting different districts are dusty, is such that a terrible explosion is possible at any moment. However much the number of such explosions may be reduced by enforcing the use of safety lamps and restricting the use of explosives, they are likely to continue to occur so long as the mines remain in their present dusty state. In this case, as in many others, the cause of ignition has not been determined, but it cannot be ascribed to blasting or the use of naked lights. It is very desirable that a thorough investigation should be made of methods by which the danger arising from coal dust may be combated.

Where the performance of the work necessary to make the working places secure is deputed to the colliers, strict supervision and the enforcement of the general and special rules bearing on timbering is necessary on the part of the owners, as they are primarily responsible in case the work is not effectually done. Care is particularly necessary to see that loaders are not allowed to work until newly bared surfaces have been examined and made safe. The death rate from falls in the district is lower than in the whole country, which is very satisfactory, considering that some of the seams in North Staffordshire are of an unusually dangerous character owing to their thickness and steepness and bad roofs. For securing the roof and sides of main roads in some cases timber is now replaced by steel girders. These are said to be generally both efficient and economical.

At many of the collieries there is room for great improvements in appliances, arrangements, and discipline; and, as a whole, the district cannot be said to have attained a high standard of management.

The butty system still prevails to a considerable extent in the district.

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This is a system by which the working of collieries is deputed more or less completely to contractors. It is a system which has often been condemned by persons interested in good mining and the welfare of miners; and, except when it is confined within certain very narrow limits, I can only add my disapproval.

I have found the colliery owners and managers generally desirous to improve the condition of the mines, and any suggestions I have made with that object have received fair consideration, and in the simpler matters have sometimes been acted on at once. The miners of the district rarely take advantage of the power conferred on them by the 38th General Rule, to appoint two practical working miners to inspect the collieries and report the result of their examination.

Mr JOSEPH S. MARTIN, South Western District.

COLLIERY managers generally acknowledge that the intention of the last Mines Act is to require an increased use of safety lamps, and many of them do not feel inclined to accept the responsibility of opposing it, but the workmen raise many difficulties, and they are sometimes hard to persuade even in their own interest, but the recent disastrous explosions, &c., some of which occurred in neighbouring collieries, should satisfy any one that the use of naked lights is an uncalled-for risk, and that the responsibility of their continuance is very great on the part of owners, their advisers, officials, and workmen who allow it.

Mr JOSEPH T. ROBSON, South Wales District.

THE kind of light which may or may not be used in a mine, or part of a mine, being a matter provided for by the 8th General Rule of the Coal Mines Regulation Act, 1887, it is clear that the onus is thrown on the owner, agent, and manager to see that "no lamp or light other than a locked safety lamp shall be allowed or used in any place . . . . in which there is likely to be any such quantity of inflammable gas as to render the use of naked lights dangerous." As remarked in my report for 1888, there is a difficulty in deciding when it becomes *likely* that there

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will be a *dangerous quantity* in any place, and this difficulty will probably exist until the rule is altered. I am strongly of opinion that it ought to be altered and made more workable by substituting the following words for those quoted above. viz. :—"No lamp or light other than a locked safety lamp shall be allowed or used in any ventilating district at any time within twelve months after inflammable gas has been found in any part of such ventilating district."

I am glad to be able to report improvement in the ventilation of some mines, and that additional ventilating fans have been started during the past year.

With regard to the important subject of blasting in collieries worked with safety lamps, a subject intimately connected with those of lighting and explosions, it is to me a satisfaction that managers are not inclined, as a rule, to countenance the firing of shots during the colliers' working shift, which may be done under the 12th General Rule, without withdrawing the men from the district, in certain cases.

Progress is also being made in introducing arrangements for laying the dust in roadways, and cases are now very rare where this important matter is entirely disregarded. I believe watering by jets has been systematically done at Llwynypia Colliery for over ten years, and at the Ynishir and one or two others for several years. Now most of the large collieries have systems of watering, similar to those at Llwynypia, which was described in my report for 1887.

The general result of the past year confirms what I have previously stated in my annual reports with regard to accidents by falls of roof and sides. The examinations again clearly showed that in a large number of cases the precautions taken to prevent a fall were far short of what were reasonably practical. It is almost inconceivable that colliers will continue to rely so much on their own judgment in the detection of weaknesses in the roofs and sides rather than do what experience shows to be necessary to guard against falls, yet such is the case ; and until owners and managers take the matter more into their own hands, and insist upon closer propping, and some safer method of protecting the sides than an occasional sprag, I do not think much improvement will take place in this, the most prolific, source of accident.

Appended to some of the reports are the questions put to candidates for managers' certificates. J. B.

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SOUTH WALES INSTITUTE of ENGINEERS.—Vol. XVI., P. 266.

AN ELECTRIC MINER'S LAMP.

By E. T. BOSTON.

THE author here gives a short description of a miner's electric lamp, together with drawings of the same. He claims that a light of 2½-candle power is given for ten hours at a cost of under one penny per shift. The weight of the lamp completely charged is 2¼lbs., which is less than the lamps in present use (the "Edison & Swan" lamp weighs 7lbs.,) and the cost complete, if manufactured in quantities, would not exceed £1.

He reserves for the present the description of the chemicals used in the battery. A. L.

SOUTH WALES INSTITUTE of ENGINEERS.—Vol. XVI., P. 232.

METALLIC SLEEPERS FOR PERMANENT WAY.

By JAMES COLQUHOUN.

THIS is a most interesting paper to any one engaged in laying down railway lines. The author enters fully into the various forms of iron and steel sleepers in use on the Continental, colonial, and home railway systems, of which he gives 43 diagrams in illustration of his subject.

He also gives statements, showing the comparative cost per mile of single road laid with 90lb. rails, chairs, and wood sleepers against the same length of road laid with the patent steel sleepers in use on the North-Eastern Railway—the first being £1266, and the latter £1409, the difference in first cost being in favour of the wood.

The above railway company have had 10,000 of the patent sleepers laid for over a year on the busiest portions of their line, and the results have been so satisfactory that an additional supply has been ordered.

A. L.

The JOURNAL of the SOCIETY of CHEMICAL INDUSTRY.

Vol. IX., P. 265.

MANUFACTURE OF BLASTING GELATINE.

By GEORGE MACROBERTS, F.R.S.E., F.C.S., F.I.C.

BLASTING gelatine, the most powerful of nitro-glycerine explosives, was patented in 1875 by Mr Nobel, of dynamite fame. It is a compound containing from 92 to 93 per cent. of nitro-glycerine and 7 to 8 per cent. of nitro-cotton, and is a clear, semi-transparent substance, slightly elastic, somewhat resembling india-rubber.

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Nitro-glycerine, the most powerful liquid explosive, is very dangerous in its liquid state during transport, storage, and, in some cases, use. To obviate any risk under these conditions, it was deemed advisable to convert it into a solid state, which was done by dissolving in it nitrated cellulose—the compound becoming more and more gelatinous in proportion to the quantity of cellulose which was dissolved therein. A safe and highly useful jelly is obtained when 7 to 8 per cent. of the nitrated cellulose has been incorporated with the glycerine, which may be used for any purpose wherever a very powerful explosive is necessary.

The author gives a lucid description of the methods and machinery used in the manufacture of the explosive, also of the Government regulations regarding tests, the quantities allowed in each building, and other particulars.

It is stated that the strongest blasting gelatine is produced when there is 7 per cent. of nitro-cotton and 93 per cent. of nitro-glycerine in the explosive, which, if compared with dynamite, will yield 50 per cent. more energy. Cheaper varieties are formed with other ingredients.

It is pointed out that its explosive qualities are in no way lessened by immersion in water. It is therefore especially suitable for submarine and such like works, where, if dynamite were used, the nitro-glycerine in it would be carried off in solution, except the cartridges were encased in a water-tight cover.

In all its varieties it is exploded by means of a detonator, as in the case of dynamite, but of a more powerful variety than what is used for the latter explosive. A. L.

JOURNAL of the SOCIETY of CHEMICAL INDUSTRY.
Vol. IX., P. 267.

MacARTHUR-FORREST PROCESS OF GOLD EXTRACTION.

By J. S. MacARTHUR.

THE author describes briefly a number of the different mechanical and chemical processes hitherto in use, by which the metal has been separated from the ore. After experimenting on ores from all parts of the world, the inventors adopted the following process, which may be stated in the author's words :—"The ore is ground to about the fineness of sand. If, instead of ore, we are working tailings from the amalgamation process, these are generally not re-ground, but treated as delivered. The finely-divided material is mixed with a solution of cyanide, say cyanide of potassium, containing on an average 0·4 per cent. of cyanogen as the cyanide of potassium or other alkali or alkaline earth. The ore and

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solution are stirred together for six hours, more or less; and when the gold is known to be dissolved, the pulp is discharged into an ordinary filtering tank, where the filtration may, if necessary, be assisted by suction, and where the ore is washed by water or by the waste cyanide solution from a previous operation. The ore, after treatment with cyanide solution, is unchanged to the eye, as almost nothing but the imperceptible proportion of gold present has been removed. The gold now being in solution, the next object is to get it precipitated, and here we encounter a serious difficulty. Gold and cyanogen have such a strong mutual affinity that it is difficult to get any substance that will separate them. The gold cannot be precipitated by any ordinary method, such as the use of ferrous sulphate or oxalic acid; even sulphuretted hydrogen and sulphide of sodium will not precipitate gold from its cyanide solution, though they precipitate silver. We had noticed, however, by experiment, that zinc precipitated gold very feebly, and tried this in the same way that copper is precipitated from its ordinary solutions by scrap iron, but scrap zinc had no effect; then granulated zinc was tried, with a most imperfect and disappointing result; then heating in presence of scrap and granulated zinc, but this had only the effect of forming urea, and assisting the precipitation very little indeed. Further, we tried zinc dust, but still there was no success. Finally, we prepared some zinc in a form like sawdust, porous, and with a large surface of bright metal. On allowing the cyanide of gold solution to trickle through a mass of the zinc, we found that it trickled out gold-free, and, better still, we found that the action became more vigorous and pronounced after a portion of the gold had been precipitated on it, doubtless as gold and zinc formed together a more powerful electro-chemical precipitant than zinc by itself. An arrangement of a porous mass of zinc like a sponge formed a chemical filter, which at once precipitated and collected the precious metal; indeed, so like an ordinary water-purifying device was this zinc filter than many non-technical visitors formed and held tenaciously to the idea that the gold was in suspension in the cyanide solution, and the zinc was used merely because of its durability. Improvements in detail were made in the direction of increasimg the surface, and decreasing the weight of the zinc, till now we have it in threads, 1lb. of which occupies about two gallons measure. The zinc in this form is possessed of enormous chemical activity, of which the strongest and most direct evidence is the fact that it burns in the air like thin shavings of wood. When the gold has been deposited, it is necessary to separate it from the excess of zinc present. The filiform structure of the zinc, and the exceedingly fine powder, as which the gold is deposited, render this an easy matter. The filiform mass of zinc, with gold powder adhering, is vigorously shaken in water, and the gold falls off, and the fibrous particles of the zinc may be collected in a sieve. The gold settles easily, is collected, and fused directly into bullion." A. L.

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CLEVELAND INSTITUTE of ENGINEERS.
Proceedings, November, 1889 (P. 13.)

GOLD-MINING IN AUSTRALIA.

By THEO. WEST, Darlington.

THE first part of this paper is descriptive of the colonies of New South Wales, Victoria, South Australia, Queensland, and West Australia, particularly with regard to their mineralogical characteristics. These colonies, the author states, are highly advanced, socially and politically, attributable mainly to the discovery of gold and other valuable minerals, as well as to the many other resources within them—the development of which affords employment for many of our surplus population.

He states that soon after the discovery of gold, nearly all the most productive spots were pitched on, especially where the metal was easily worked, and exhausted by the simplest of contrivances in the hands of men who knew little or nothing of mining or minerals.

The following is a section of the deposit in which the gold is usually found :—On the surface is a thin layer of top soil, then strong ferruginous sand, fine gravel, then alternating layers of sand and gravel, coarser and coarser the deeper one goes, then large pebbles, and, lastly, boulders resting on the rock. It is in the latter stratum that the largest finds were obtained, or in the chinks and holes of the bed rock. Sometimes the gravel and pebbles were naturally bedded together with clay which, on exposure to the weather, readily fell into pieces, whilst at other points it was found to be bedded hard with what was called cement, probably due to the lime, iron, or silica contained in it.

In estimating as to the probabilities of ground paying for gold working, the yield of gold per ton of material handled is only one of the elements which have to be taken into account, as it will greatly depend on whether the material is hard or soft, near the surface or requiring to be raised from a depth, wash-dirt scarce or plentiful, and a good supply of water obtainable near the site of the operations.

The process of washing the alluvial gold is next gone into, and depends on the well-known theory that the heavier substances always sink to the bottom, consequently all the apparatus used in this operation is designed and constructed on the principle that, while water has the power to wash away the base material, the metal is almost entirely left behind. The processes described and illustrated are :—(1) By means of the "hand cradle," which is very tedious and laborious ; (2) The "Tom," which better enabled poorer ground to be worked to pay than what could be done by the cradle ; (3) By "sluice boxes ;" (4) The "puddling machine," for clay wash-dirt ; and (5) By "hydraulic sluicing," an American process, which is objectionable on account of the large amount of *dêbris* that was washed into the streams and water-courses, and deposited on the low-lying lands.

It is stated that, as the alluvial deposits operated on were exhausted,

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and owing to the finding of small pieces of quartz with gold adhering to them, the attention of miners was directed to the quartz veins which were found traversing the various districts, some of them for miles. They were usually found to dip at an angle of 40°, although at times a flat-lying reef, several feet in thickness, is found extending over a considerable area, but generally poor in metal.

The veins are found to vary in colour from pure white to black; the clear white are usually barren.

In the mining of the veins, a depths of about 330 fathoms has been reached, necessitating the employment of experienced miners and the use of costly machinery and other plant for the purpose of raising the ore to the surface, and skilful application of refined chemical processes, to be used for wholly extracting the gold from it.

The author gives a sketch of a ten-stamp battery used for crushing the ore, also of "Chilian Wheels," and many of the other machines in use many years ago, as well as descriptions of the various mechanical and chemical processes now in use—such as the Cassell's patent, acting on the principle of decomposition of common salt and crushed ore by galvanic action, dissolving the gold, which is filtered through asbestos cloth and precipitated; and also the MacArthur-Forrest Amalgamator, by which the ore, after being firmly ground, is mixed with the cyanide of potassium stirred for 8 or 10 hours by a four-bladed propeller, then filtered through fine zinc, and deposited as a cyanide of gold. A. L.

Transactions of the LIVERPOOL ENGINEERING SOCIETY.

SOME RECENT EXPERIMENTS ON IRON AND STEEL AND RIVETED JOINTS.

By A. W. BRIGHTMORE. Vol. XI., P. 1.

RECENT experiments by Wöhler, Baker, and others, have brought out some new and important facts illustrating the effect of a live load on structures of iron and steel. In designing structures in iron or steel, it has been considered sufficient to allow a certain factor of safety of working stress compared with the breaking stress due to a statical pressure. But another factor will require to be considered when a live load has to be dealt with. If a bar of iron or steel be subjected to a load varying from zero to a maximum, it has been found by Wöhler that it will not bear the indefinite repetition of a load greater than two-thirds of its ultimate statical strength. If the load vary from a pull of a certain amount to a thrust of equal magnitude, then the bar will only bear the indefinite repetition of about one-third the statical strength. That is, wrought iron of an ultimate strength of 22·8 tons per sq. in. will only withstand, indefinitely repeated, a pull varying from 0 to 15·25 tons per

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sq. in., or a thrust of 8·6 tons per sq, inch, and a pull of the same amount alternately. With the harder kinds of steel, the diminution of strength under these conditions is more marked.

In testing a bar of wrought iron or mild steel to destruction by a gradually increasing tensile stress, there are two well-defined points of change. The first is the real elastic limit, when the elongation ceases to increase proportionally to the load; and the "breaking-down" point—the commercial limit of elasticity—when, without any increase of load, an increased elongation takes place, the load having to be diminished before the test-piece can carry it without further extension. Professor Kennedy observed another well-marked point which is reached before either of the two mentioned. With a load of 40 per cent. of the breaking load, he found that a slight, but quite definite, permanent set takes place, although the elongation continues proportional to the weight for some time longer—till what has been already called the elastic limit is reached.

The elastic strength is a variable quantity, and may be increased nearly to the breaking strength; but Bauschinger has shown that, as the elastic limit in tension is increased, the elastic limit in compression is reduced. This explains the comparative weakness of a bar under alternate extensive and compressive stresses. The same experimenter has proved that, if a load be repeatedly applied less than a certain amount, according to the material, the elastic limit will be increased to more than the load, and the bar will bear indefinite repetition of the stress. But if the load be so great that the elastic limit cannot increase above it, the bar will break with few applications of the load. He has also found that the elasticity of a material may have been raised or lowered from the normal in process of manufacture, but a few alternating stresses slightly above the elastic limit reduces the elasticity to a natural definite amount which appears to be equal to the load that can be borne indefinitely as a pull or a thrust alternately. It seems probable that the point noticed by Professor Kennedy as the beginning of permanent set corresponds to this point of natural elasticity, for Baker's experiments on mild steel show that only a load of 40 per cent. of the ultimate tenacity can be indefinitely sustained alternately as a tensile and compressive strain. With hard steel, Baker found this proportion reduced to about 25 per cent.

In a riveted joint there are three stresses—(1) The tension in the plate between the rivets; (2) The shearing stress in the rivets; (3) The crushing force between the plate and the rivets. Two of these stresses being allowed for in designing a joint, the other must be seen to be within safe limits. The first two stresses are simple, and easily provided for in a joint, but the third indirectly influences the others, and complicates the calculation. The experiments of Professor Kennedy have shown that if, in a single shear joint, the compression be greater than 43 tons per sq. inch for mild steel, the shearing and tensile stresses are rendered

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variable and of unequal distribution, and the strength of the joint impaired. In the case of a double shear joint, the limit of compression is somewhat higher. The maximum compressive stress allowable for a riveted joint in mild steel is—For single shear, 43 tons ; and for double shear, 50 tons per sq. inch.

It has been found that the tenacity of mild steel plates is increased by drilling from 8 per cent. to 20 per cent. in $\frac{3}{4}$in. plates, and a rivet pitch of 1·9 times the diameter of the rivets. The probable explanation of the phenomenon is the more equal distribution of stress in perforated compared with unperforated plates.

In double riveted joints, it is important that the diagonal area be sufficient, and should be not less than one-third in excess of the cross sectional area of plate between two contiguous rivets in the same row. The friction between the plates in a joint reduces very much the stress on the rivets, so much so that M. Considéré and others have shown that the friction at first—and, in joints not subject to vibration, possibly always—transmits the entire tension in one plate to the other, and so prevents any shear on the rivets, which are then only subject to the tension causing pressure between the plates, giving rise to friction. In such circumstances, the joint may be stronger than the plate itself. In this connection, the size of the rivet-heads is of importance, as increased diameter therein would affect the distribution of friction, and assist in preventing bending of the joint. Hand riveting, as compared with machine riveting, appears to be of equal strength ; but the latter is much better in a comparison of the points at which slip begins in each. The load per rivet at which slip is first apparent is in both approximately a constant amount, but machine riveting can stand more than double the load per rivet that hand riveting can bear without slipping. This is of great importance in a comparison of the relative efficacy of the two methods, as the prevention of slip is essential particularly in a steam boiler, where slip means leakage. J. H.

Transactions of the MANCHESTER GEOLOGICAL SOCIETY.

THE DURATION OF OUR COAL SUPPLY.

PRESIDENTIAL ADDRESS by HENRY HALL, H.M. Inspector of Mines. Vol. XX., P. 379.

TWENTY years have passed since the Royal Commission reported on the coal supply of the country. How far has the estimate then made been verified by experience during these years? The main questions the Commission had to consider were (1) The available quantity of coal, and (2) The rate of consumption. The report fixed the quantity of coal available in the known coal-fields, at depths not exceeding 4000ft. (which the Commission considered the limit of practicable working), at 90,207 million tons. In addition to this quantity, it was estimated that 56,273 millions of tons, covered by Permian rocks, lie above the 4000ft. limit,

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making a total of 146,480 million tons. The quantity of coal between 4000 and 6000ft. deep is estimated at 29,000 millions of tons. The Commission considered the question of the possible existence of coal under the Cretaceous rocks of south-eastern England, where it was recently reported that the coal measures had been pierced by a bore-hole, and came to the conclusion that the evidence was not sufficient to justify any credit for coal therein being taken in the report. It is obviously the more difficult problem to estimate the duration of the estimated coal supply. Two bases of calculation were used by the Commissioners—first, that the consumption would bear a fixed relation to the population, which was estimated at about 4½ tons per head per annum. On this assumption, they estimated that the 146,736 millions of tons would last for 360 years. The second method was to allow an annual increase in production of three million tons, being the average rate of increase during the preceding fourteen years. On this basis, the coal would be exhausted in 276 years.

Taking the first method of calculation, Mr Hall calculates that the consumption estimated by the Commissioners for 1891 is 10 per cent. less than the actual consumption in 1888. According to the second method, the output of 1888 was estimated at 164 million tons, and the production was really 170 million tons—a difference of only rather more than 3 per cent. During the past ten years, the annual increase in production has been, on the average, four million tons in place of three-and-a-half millions—the average of fourteen years immediately prior to 1869. If this rate of increase be continued, the 276 years of the Commissioners will be reduced to 249. All these calculations are based on the assumption that workings may be carried to a depth of 4000ft., where the estimated natural temperature is 116° Fahrenheit. This, Mr Hall believes, ought to be 130°, and he places the reduction of natural temperature possible by ventilation at 15°, against 7° mentioned in the report of the Commission, and so makes the probable temperature of the workings at 4000ft. 115°. Now, workmen complain of heat where temperature rises above 80°, and the conclusion reached is that, with our present appliances, coal can only be worked at great expense, if at all, at greater depths than that which gives a natural temperature of 100°.

It may fairly be questioned whether any considerable quantity of coal can be got from beneath permian rocks, and consequently the available supply is reduced to 90,207 million tons, if coal worked beneath the permian be set against what may be found unworkable at depths less than 4000 feet, and on this assumption there will be no more coal workable in 171 years from the present time.

From particulars furnished by certain mine owners, it appears that the cost of coal in 1889 has been only 9d per ton above the cost in 1869, while the costs in 1879 and 1869 are about equal. The difference in the former case is probably due to increased cost in labour. J. H.

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TRANSACTIONS of the MANCHESTER GEOLOGICAL SOCIETY.

ON THE PROBABLE DEPTH AT WHICH COAL IS NOW BEING WORKED IN THE BRITISH ISLES.

By PROFESSOR HULL. Vol. XX., P. 47.

IN connection with the duration of our coal supply, it is of interest to enquire into the average depth at which coal is being worked, and the rate of increase of that average. If at the introduction of steam winding engines about 1820 it be supposed that 100 yards was the average depth at which coal was mined; and that now, as a near approximation, the average depth be taken at 350 to 400 yards then the rate of increase in depth is about 4½ yards per annum if uniform, which it has not been. For the counties of York, Derby, and Notts the average depth at present is probably near 250 yards, while in Lancashire and Cheshire it is much greater—say, nearer 400 yards. J. H.

TRANSACTIONS of the MINING ASSOCIATION and INSTITUTE of CORNWALL.

INAUGURAL ADDRESS BY CAPTAIN JOSIAH THOMAS.

Vol. II., P. 7.

ALTHOUGH almost every kind of metallic mineral exists in Cornwall, the only mines that have been profitably worked are mines of copper, lead, and tin. The first two are nearly worked out, so far as known at present; but the latter is practically inexhaustible. As the copper mines are deepened tin takes the place of copper in the lodes, and the deepest tin mines are the best. While machinery has greatly improved during late years, it would appear that the Cornish pumping engine is becoming less efficient. Forty years ago there were pumping engines giving a duty of eighty, ninety, or even one hundred millions. The average duty at present is only fifty-five millions, and no engine does as much as eighty millions of foot pounds per bushel (94 lbs.) of coal. J. H.

HOURS OF LABOUR IN MINES.

THERE has recently been prepared from particulars furnished by H.M. Inspectors of Mines, and issued from the Home Office, a "Return showing the average number of hours and days daily and weekly worked by men and boys from bank to bank, and otherwise in and about mines, in the United Kingdom, under the Coal Mines and Metalliferous Mines Acts." The following table shows the portion of the return relating to Scotland :—

J. B.

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Inspection Districts / Names of Counties	1. EAST SCOTLAND. Coal Mines. Clackmannan.	Edinburgh.	Fife, Kinross, and Perth.	Haddington.	Lanark (part of).
1.—Men and Boys engaged in getting Materials:					
Number of persons	591	2,703	5,170	596	11,662
Average number of hours per day from bank to bank	8·60	8·71	8·54	8·60	9·28
Average intervals allowed for meals per day (hours)	1·02	·67	·60	·80	·93
Average number of hours per day actually worked at the face	7·17	7·40	7·27	7·35	7·88
Usual number of days worked per week	5·5	5·5	5·5	4·5	5·5
2.—Men and Boys engaged in conveying Minerals from the Face to Pit Bottom:					
Number of persons	187	988	1,380	153	3,668
Average number of hours per day from bank to bank	8·20	8·96	8·64	8·72	9·51
Average intervals allowed for meals per day (hours)	·93	·74	·57	·70	·97
Usual number of days worked per week	5·5	5·5	5·5	4·5	5·5
3.—All other Underground Workers not included above:					
Number of persons	194	608	1,124	80	1,644
Average number of hours per day from bank to bank	9·30	8·72	8·56	9·05	9·35
Average intervals allowed for meals per day (hours)	·98	·75	·57	·80	·93
Usual number of days worked per week	5·5	5·5	5·5	4·5	6·0
4.—Persons employed on the Surface:					
Number of persons	230	914	1,452	175	2,839
Average number of hours per day, exclusive of meal times	9·42	9·30	9·04	9·70	9·05
Average intervals allowed for meals per day (hours)	1·44	1·08	1·36	1·15	·98
Usual number of days worked per week	6·0	6·0	6·0	6·0	6·0
5.—Total Number of Persons Employed above and below Ground	1,202	5,213	9,126	1,004	19,813
6.—Usual Number of Hours per Day during which Minerals are Drawn to the Surface	9·0	9·0	8·0	8·0	8·5

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		2. WEST SCOTLAND.						
		Coal Mines.						Metalliferous Mines.
Linlithgow.	Stirling (part of).	Ayrshire.	Stirling (part of).	Lanark (part of).	Dumbarton.	Renfrew.	Argyle and Dumfries.	—
2,598	2,228	7,499	845	8,011	792	532	205	139
9·00	8·82	9·26	8·81	9·4	8·89	9·31	8·04	8·54
·85	1·11	·99	·90	·91	·96	·96	1·00	0·73
7·85	7·70	7·55	7·41	8·09	7·71	7·93	6·42	7·69
5·5	5·0	5·2	5·43	4·93	5·17	5·3	5·77	5·29
938	700	1,078	369	2,331	358	243	29	22
9·02	9·09	9·33	8·95	9·42	8·92	9·11	9·31	6·82
·85	1·21	·94	·79	·92	·92	·95	1·91	0·66
5·5	5·0	5·26	5·65	5·01	5·33	5·27	5·64	5·14
504	235	1,178	283	1,802	266	161	46	16
9·24	10·32	9·1	9·1	9·71	9·10	9·56	9·16	·11
·82	1·14	·9	·87	·91	·85	·97	1·94	·5
6·0	5·5	5·5	5·68	5·31	5·46	5·73	5·69	6·0
708	521	1,481	307	2,246	304	217	73	148
8·68	8·80	8·75	9·07	9·22	9·07	8·86	9·68	9·98
·92	1·35	1·05	·99	1·0	·93	·99	1·79	1·03
6·0	6·0	5·95	5·98	5·72	5·89	5·88	5·69	5·53
4,748	3,684	11,236	1,754	14,390	1,720	1,153	353	325
8·0	8·0	7·86	8·16	8·65	7·73	8·12	8·0	6·93

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TRANSACTIONS of the MINING ASSOCIATION and INSTITUTE of CORNWALL

ON ONE OF Dr ANGUS SMITH'S METHODS OF TESTING AIR.

By C. LE NEVE FOSTER. Vol. II., P. 40.

THIS is a simple and inexpensive method of testing the amount of carbonic anhydride in the air of a mine. It is a slight modification of the method proposed by Dr Smith in 1864. The apparatus required consists of :—

1. One 8oz. bottle and cork.
2. One 5oz. bottle and cork.
3. One bottle of lime water with excess of lime.
4. One pipette or measure holding ½oz.
5. Four ½oz. bottles corked.
6. One ¼oz, bottle containing an alcoholic solution of phenolphthalein.
7. One piece of indiarubber tube about a foot long.

Everything necessary can easily be obtained in a chemist's shop except the phenolphthalein, which Mr Foster offers "to furnish *gratis* to any *bona fide* miner or mine agent in the United Kingdom."

The operation of testing air is as follows :—"After the bottle (No. 3) has been well shaken up several times with the excess of lime, the solution is allowed to stand till it is quite clear, ½oz. of it is measured exactly and poured into the 5oz. bottle, which is then filled with distilled water or boiled rain water. This gives a solution of one tenth the strength of the original lime water. Add a drop or two of the solution of phenolphthalein, and the lime water at once assumes a beautiful pink colour, which remains so long as there is any lime unneutralized. This dilute lime water is now of a strength that ½oz. of it will neutralize the carbonic anhydride in an 8oz. bottle, if the air in it contains ¼ per cent. of this gas by volume. This per centage has been proposed as a standard which should not be exceeded."

"In order to make a test, fill the 8oz. bottle with the air of the place by sucking out its contents with a piece of indiarubber tube, of course taking care not to breathe into it afterwards, then add ½oz. of dilute lime water. Cork the bottle and shake it. If the pink colour disappears, the air contains more than ¼ per cent. of carbonic anhydride; if the colour is not discharged it contains less than that amount." This method cannot be said to be strictly accurate because of variations in temperature and pressure, although these sources of error tend to neutralize each other in mines. It is, however, sufficiently accurate to render valuable service, especially in Cornwall, where lung disease is very prevalent among miners, as shown by mortality returns for 1881-2-3, when out of 927 Cornish miners who died 579 died of pthisis and diseases of the respiratory system. If it is desired to ascertain the exact amount of carbonic acid in air this can be done by Dr Smith's apparatus described by Dr Foster in the reports and proceedings of the Miners' Association of Cornwall and Devon for 1882, page 7. J. H.

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JOURNAL of the BRITISH SOCIETY of MINING STUDENTS.

THE EFFECT OF COAL WORKING ON THE SURFACE.

By H. F. BULMAN.

GIVEN certain conditions—such as a seam of coal of known depth, inclination, and section, the system of working being known, and the character of the roof and the overlying strata to the surface—the question is, what effect will the exhaustion of the coal have on the surface? how far will the "draw" extend? and how long will it be before the movement ceases?

Questions under one or other of the above heads are daily arising for solution amongst mining men, but, as far as the writer knows, there are few facts recorded to enable one to arrive at a satisfactory conclusion. The only practical trial recorded is that made and noted by Mr James S. Dixon, M.E., in the Transactions of the Mining Institute of Scotland (Vol. VII., page 224) in connection with the working out of the Ell coal seam at Bent Colliery, Hamilton, at a depth of about 112 fathoms, levels being taken for a period of about three years, in which case the conclusions arrived at were (1) the subsidence was about 73 per cent. of the total thickness of seam; (2) the wave of maximum subsidence followed the working face at an average distance of 186 ft., or about 1 horizontal to 3½ vertical, and the "draw" at the ends of the line was 100 ft. and 83 ft., or 1 in 6½ and 1 in 8·78; (3) the movement of surface had ceased in about 18 months after the goafing of the seam, and depth of subsidence was not the same all over the area worked, but was greatest in the centre.

Callon says that in a seam worked longwall, and the waste properly stowed, the pressure of the overlying strata is greatest in the middle, and tails off towards the boundaries of the excavation, where the fracture will take place in the stratum on the top of the seam worked and at right angles to it. The fracture will gradually extend upwards to the surface, and will always be at right angles to the bedding plane.

With a thick seam and weak roof in pillar working the tendency will be to form a funnel shaped cavity widening upwards, and with a strong roof the reverse will take place. In both cases as soon as the cavity is filled with broken rock the subsidence will go on as in a longwall working.

The author gives a number of extracts from a memoir issued to the Municipal Council of Leige by M. Gustave Dumont, who were afraid of the effects that the coal working would have on the houses of the town. The fundamental principles which he asserts are that with the system of working then followed (longwall and stowing) strata covering horizontal coal seams always break sooner or later, whatever their thickness, and that the planes of fracture are perpendicular to the plane of the beds and pass through the limits of the area worked. This is the same view as expressed by Callon.

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When the coal seams are inclined there will not be the same intensity nor the same extent of movement.

The intensity of the pressure is diminished by reason of the obliquity which its direction must take in order to thrust the detached block into the hollow formed below it.

In the paper are a number of diagrams treating of the subject in connection with the working of seams lying at a steep angle. A. L.

SOUTH WALES INSTITUTE of ENGINEERS.

WIRE ROPES.

By Mr T. H. Deakin.

By the introduction of wire ropes for mining purposes in 1840, it was made possible to wind from greater depths and at increased velocities than what was formerly done with the hemp rope. Up to the year 1860 they were made with charcoal iron wire, having a breaking strain of about 40 tons per square inch, and latterly crucible steel was tried, which had increased strength, but as the quality was uncertain it fell into disuse for a time; however, improvements have been made in its manufacture, and now its tensile strength is from 75 to 85 tons per inch section, or about double that of charcoal wire.

Homogeneous steel was used in the construction of cables in 1865, but as the results given were very irregular, little of it was used for pit ropes until 1870, when the quality was much improved by Bessemer, and has now largely displaced charcoal wire. Ploughed steel ropes, from which is obtained by far the best results, the wires breaking when the strain on them reaches from 100 to 130 tons per square inch, are the toughest of any made; so that now instead of having hemp ropes breaking at 3½ tons, or iron wire ropes at 40 tons, we can obtain ropes capable of being strained up to 120 tons per sectional inch before breaking point is reached, or fully 30 times the strength of hemp ropes; causing the latter to almost wholly disappear from pithead scaffolds; and charcoal iron ropes have so far followed, that if wanted, care requires to be taken to see that they are supplied.

For shallow pits and where the load is light, it is found that Bessemer steel ropes are the most economical, because of the first cost being considerably under that of those made from the higher qualities of steel. During the past few years patent crucible steel ropes have been in general use where the loads are heavy, and being wound at increased velocities from deep shafts. In still deeper shafts ploughed steel is being used because of its greater strength, which is due to the increase in the per centage of carbon contained in it.

The author explains the meaning of the terms "breaking strain," "torsion," and "working load," the latter he puts at from one-sixth to one-tenth of the first, according to circumstances.

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Make.—With regard to the make of ropes it is stated that no hard and fast rule can be laid down for indiscriminate use; but when quotations are asked for from makers it is thought better to state exactly under what conditions the rope is to work, whether in a dry or wet shaft, downcast or furnace, form of drum, diameter of pulley, load and speed at which it is to work.

In the author's practice he found that, on comparing the life of ropes in the same shaft, a four inch iron wire rope working from an 8ft. drum lasted on an average 6 months 18 days in an upcast, and in a downcast 8 months 16 days; and a $2\frac{3}{4}$-inch ploughed steel wire rope, taking an average of three (as with the iron), worked for 14 months 6 days, and 25 months 14 days in the upcast and downcast shafts respectively. The value of the ropes at present prices is about 3s 5·6d per fathom for the iron, and for the steel 4s $11\frac{3}{4}$d. Comparing the first cost and time worked by each, the final cost is in favour of the latter as 5s is to 9s 1d. The other advantages gained were (1) one-eleventh greater breaking strain; (2) the engines had less work as the rope was of less weight; (3) when taken from the shaft it could be used for haulage purposes, whereas the iron ropes were useless.

Flat Wire Ropes.—It is found to be more difficult to get a perfect flat rope than a round one; the latter is made throughout by machinery, whereas the stitching of the flat one is done by hand, consequently the wires may be drawn tighter on one side than the other, and if so, the rope when in use will not work evenly, thus causing one side to take more than its own share of the work, and trouble is often experienced with the stitching getting cut before the body of the rope is done. On comparison of the costs, it is found to be more expensive than the round rope. The disadvantages may be stated as (1) the greater first cost, (2) very much shorter life, and (3) more liability to failure. In all they are from 30 to 50 per cent. more costly. Against this, the only advantage gained is the greater diameter of drum of the descending rope to help to lift the load from the bottom of the other shaft.

Makers of Rope.—Samples of various ropes have been supplied to the author by the makers, drawings of which are attached, as follows:—(1) One of the first kind patented by Mr Newall in 1838, composed of 6 strands of 6 wires with hemp cores in the strand and rope; (2) patent protector rope, made by D. H. & G. Haggie, Sunderland, of 6 strands, each of 7 small wires, around a hemp centre, each strand being protected by a covering of wire. For this rope it is claimed that as the strands are protected from friction by the wire covering, the full strength of the rope is retained until the covering is worn through; and as smaller wires are used, more pliability is gained, and it is therefore better adapted for working round sharp curves; (3) the other ropes shown and described, of which there are drawings, are made by Messrs Dixon & Corbit, Newcastle-

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on-Tyne; Messrs G. Elliot & Co.; Westgarth's patent; and Messrs Cradock & Co., Wakefield, the latter making on Lang's specification.

Treatment of Ropes.—Ropes that are in stock for a time should be kept thoroughly dry, and periodically turned over and oiled with a good oil, and when wanted should be placed on a reel to prevent kinking which would seriously damage them. It should be kept free from rust when in use, which may be best done by a coating of thick oil applied when being unwound from the reel, care being taken to work it well into the crevices, after which ordinary rope oil should be put on for a few days, and when working once a week.

Wear.—If ropes are made of hard steel in all probability the metal will crystallise, and consequently the toughness and power of the wires to resist torsion will be lessened. It is stated that the toughness of wire decreases with its increase of size, therefore a rope of smaller wires would give better results than one of larger wires—effective sections being equal.

Generally pit ropes give away first at lifting point, *i.e.*, on the top of the cage; especially so if the rope winds from the under side of the drum, causing a double bend. Damage may be done to them through loading in mid-shaft without the use of shuts on which to rest the cage, as all sudden jerks should be avoided.

Caps or Sockets.—Drawings showing the various methods by which the attachment of the rope (flat or round) is made to the cage are also appended.

Splicing.—The system recommended by two manufacturers (Mr Scott and Messrs Cradock), illustrated by diagram, is inserted in the paper, and is well worthy of consideration.

Drums and Pulleys.—The diameter of the drum requires very careful attention on the part of those engaged in fitting up of collieries, as it has a distinct effect on the life of the rope. The acknowledged rule by the best rope makers is, for ropes made of 6 strands of 6 wires, to allow one foot of diameter of drum for each pound the rope may weigh per fathom. This is the general rule for ropes made on the old construction; but for ropes made on Lang's principle, the diameter may be reduced one-seventh. Spiral drums do not appear to be in favour with rope makers, and in cases where taper ropes are in use, they are detrimental to them.

Care should be taken to see that the groove in the pulley is large enough for the rope, as it is better to be too large than small. If possible the drum and sheave should be of the same diameter, as the wires are not subjected to varying bends.

The author concludes his paper by recommending that records of work done by ropes should be kept at the colliery under the following heads: —Date of invoice, date of arrival, maker, description of rope, weight, cost, when put to work, when taken off, duration, quantity raised, cost per 1000 tons, colliery worked, days, remarks.

Mr F. W. Scott's and Messrs Cradock's tables of strength and weight of round and flat wire ropes are inserted in the paper. A. L.

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INSTITUTION of MECHANICAL ENGINEERS (Proceedings, July 1889. No. 3, p. 500),

GAS ENGINES.

By M. EDOUARD DELAMARE-DEBOUTTEVILLE, Rouen.

Although the gas engine as we know it is one of the most recent achievements of modern engineering skill, still it is interesting to notice that the theory of it belongs to the last century, and that the first definite description of such an engine was published seven years before gas works were known. Probably Watt's splendid inventions and improvements on the steam engine, which were then only beginning to be extensively applied, had a stimulating effect on the inventive minds of the period, and set them to look in other directions for a source of motive power. However that may be, we find that on 31st October, 1791, John Barber published the first description of a gas motor. As there were no gas works at this date, he described what he considered the best processes for producing the gas. He proposed to distil coal, wood, oil, or other combustible in a retort, and then by means of a pump to inject the gas into a cylinder in which the explosion should take place. A second pump injected air in suitable proportions, and ignition was effected by means of a match or candle. Although this machine could never have been a practical success, it is very interesting as representing the first clear idea of an engine driven by explosive gas. Three years later Robert Street described a gas engine with a slide valve containing the flame for ignition. William Barnett's invention, dated 18th April, 1838, marks an important advance in the history of the gas engine. He describes three kinds of motors—the first single acting, the second double acting, while in the third and most interesting the important principle of compression was introduced. Pumps were used for compressing the air and gas, and for clearing the cylinder of the spent gases. For ignition Barnett proposed to use a cock with a hollow plug containing a gas burner. When turned into one position the port in the plug put the burner into communication with an external flame which lit it, and being then turned rapidly into another position, it brought the flame into contact with the compressed gas in the cylinder. John Reynolds in 1844 proposed an electric battery, the current from which was to heat a platinum wire to incandescence and thereby cause ignition. A contact-breaker transmitted the current at the instant required. Shepherd in 1850 used an electro-magnetic machine for ignition. Barsanti and Matteucci used a Bunsen battery with a De-la-Rive multiplier, the sparks from which caused the ignition. Subsequently in the Lenoir engine the multiplier was replaced by a Ruhmkorff coil. Early in 1860 Lenoir produced the first practically successful gas engine. He afterwards added various improvements, but his engine did not realise all the success it deserved. Its two chief drawbacks were defective ignition and

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extravagant consumption of gas. In 1862 Mr Beau de Rochas published a specification dealing in detail with the conditions theoretically required for realising the best results from the elastic force of gas :—(1) The cylinders should have the largest capacity possible with the smallest circumferential surface ; (2) the speed should be as high as possible ; (3) the expansion should be as great as possible ; (4) the initial pressure should be as high as possible, and the following sequence of operations should take place during four consecutive strokes—*(a)* drawing in the gaseous mixture during an entire (forward) stroke, *(b)* compression during the second (return) stroke, *(c)* ignition at the dead point and expansion during the third (forward) stroke, *(d)* expulsion of the burnt gas during the fourth (return) stroke. This cycle has been adopted and followed in all the subsequent successful engines. In 1867 Messrs Otto and Langen produced their motor, which was a practical success. The slide valve was ingenious, and the economy of consumption was considerable, but its working was both noisy and violent. A description of this engine was given to the Institution in 1875 (Proceedings, p. 191).

The well known Otto engine was introduced in 1876, and subsequently improved in 1877. This engine held the field for a good many years, and for a considerable time Dr. Otto was the only maker of gas engines.

It can be easily seen that for certainty of working with the gas engine, it is indispensable to have absolutely sure ignition powerful enough to explode the poorest gas. This is completely realised only by the electric spark, and all other modes of ignition have, in the author's opinion, proved inferior to it. This method of ignition has consequently been followed in the

SIMPLEX ENGINE,

the joint invention of the author and Mr Leon Malindin, and which was brought out in 1884. It is on the plan of the four-stroke cycle of Beau de Rochas, and its working is in the main the same as that described by that gentleman ; but there are several novel details which it presents as compared with its predecessors in regard to the mode of ignition, gas mixing, governing, starting, working with petroleum vapour, and with poor gas. The mode of ignition is by a combination of the slide valve and an uninterrupted stream of electric sparks, playing within the recess of the slide valve, the advantage of this arrangement is that the moment of ignition is regulated by the edges of the parts as in the steam engine.

Gas Mixing.—The air and gas are mixed in an external mixing chamber, the air entering at one side and the gas at the other. After meeting and mixing, they are violently drawn into the cylinder by the motion of the piston, through a passage which is at first circular, then conical, and then rectangular, and are thus intimately mingled.

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Governing.—The two methods adopted for regulating the speed of gas motors are—1st, full admission or none, that is to say that the supply of gas is totally cut off for one or more strokes whenever any increase of speed occurs; 2nd, proportional admission, that is to say, more or less gas is admitted forming a more or less powerful explosive mixture accordingly as the engine runs slower or faster. The second method at first sight appears the more rational, but it entails certain inconveniences which have led to its rejection. The stronger or weaker mixture resulting from a proportional admission of gas, is liable to become non-explosive, either because it is too rich or because it is too poor. In either case, no ignition takes place, and a charge of gas is expended to no purpose; and under certain conditions this waste may amount to a considerable proportion of the total consumption. On this account a most ingenious and sensitive governor has been devised and applied to the Simplex engine, which will check an increase of speed of one per cent. by preventing the opening of the gas valve until the speed has become normal.

The Simplex engine has been tested with the following gases:—Coal gas, Dowson gas, gas from the Lencauchez generators, petroleum vapour, wood gas—and with all of them it works equally well. In spite of the high initial pressure to which the explosive mixture is subjected, the working is smooth and noiseless. This result is obtained by delaying the ignition so that it shall occur, not at the dead point as proposed by Beau de Rochas, but somewhat later when the piston has made a small part of its forward stroke. At first sight it might be supposed that this would entail a loss of power, but experience shows that though the area of the indicator diagram is reduced, the work measured by the friction brake is greater. Starting is also made much easier by this method of working.

Tests of Consumption.—A 50 H.-P. engine working with a load of 35 to 40 effective H.-P., consumes daily with a Dowson generator (rather too small) 511bs. of English anthracite coal per hour, equivalent to a consumption of 1·475 to 1·296 lb. per effective H.-P. per hour, inclusive of everything. A 16 H.-P. engine supplied with coal gas, and working with a load of 12 effective H.-P., uses 2·300 cubic feet per day of ten hours, or say 19·4 cubic feet per effective H.-P. per hour. These two engines are in constant work, and their consumption is ascertained from the daily records kept for several months, and not from experiments.

From the low consumption obtained by the use of poor gases, a considerable development of the manufacture of large gas engines may be safely predicted, for their consumption is more economical than that of the best steam engines. In the author's opinion this has now been conclusively proved. J. P.

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THE JEFFREY ELECTRIC COAL MINING MACHINE.

ENGINEERING AND MINING JOURNAL, NEW YORK.

The machine is run by an electric motor forming part of the coal cutter, and the pressure required does not exceed 220 volts, with a current not to exceed 10 ampéres. This pressure is found by experience to be safe, and no injurious accidents can arise from its use.

The machine itself consists of a bed frame, occupying a space 2 ft. wide by 7 ft. 6 in. long. composed of two steel channel bars firmly braced, the top plates on each forming racks with their teeth, downward into which the feed wheels of the sliding frame engage.

Mounted upon and engaging with this bed frame is a sliding frame, similarly braced, consisting mainly of two steel T bars, upon which are mounted at the rear ends an electric motor, from which power is transmitted through straight gear wheels to the rack, by means of which the sliding frame is fed forward. Upon the front end of this sliding frame is mounted the cutter bar, held firmly by two solid steel shoes, with suitable brass boxes. The cutter bar contains steel bits, made of tool steel held in place by a set of screws. When the cutter bar is revolved these cutters or bits cover its entire face. The cutter bar is revolved by one endless steel chain from the driving shaft, and, as it is revolved is advanced by the above mechanism into the coal or other material to be undercut to the desired depth. The feed is thrown on and off by means of an automatic lever. The cut under the coal—6 ft. deep by 3 ft. wide, 4 in. high—is made in 3¼ to 5 minutes, and the cutter bar withdrawn in from 4 to 6 minutes.

At this rate on an average for 10 hours, it is claimed fairly that the machine will undercut from 600 to 1000 square feet of floor surface in 10 hours. In one case 1200 square feet have been cut in 10 hours, and the Shawnee and Iron Point Coal and Iron Coy. is now operating with these machines in its coal mines in Ohio, and, in addition, lighting and hauling by electricity. The Ellsworth and Morris Coal Coy., of Hocking Valley, has also adopted them, displacing the Jeffrey compressed air machines, which had given them great satisfaction ; but the conclusion is that the results attained with the electric machine are even more satisfactory. The machine can be handled easily by two men, and will cut equally well in fireclay bottom as in coal.

The machines are manufactured by the Jeffrey Manufacturing Coy. of Columbus, Ohio. A. L.

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MANCHESTER STEAM USERS' ASSOCIATION—Annual Meeting, 1889.

STEAM BOILERS.

THE special service branch of the Association's proceedings is of growing importance. Under it assistance is rendered to members in putting down new boilers. The chief engineer first advises as to number, description, and size of boilers, and as to arrangement of setting and steam pipes, sending if necessary an assistant inspector to visit the works and make a plan of the site. A detailed specification is then drawn out, embodying the result of the Association's experience, and sent to approved makers, with form of tender. These approved makers are such as have works with the machinery necessary for producing good work, with a drawing office and staff of draughtsmen for turning out such general arrangement and setting plans as are required by the Association. To such makers only specifications are sent. By this system offers are made upon a common standard, and only by competent makers. The purchaser then selects for himself from the offers received, and the Association undertakes the inspection of the work, seeing that the quality of metal is satisfactory, plates properly bent, rivet holes drilled and not punched, and generally that all the work is properly done. When completed the boiler is tested by hydraulic pressure by a M.S.U.A. inspector, who takes measurements to see that no straining takes place nor signs of weakness manifest themselves. All tests and inspections satisfactorily passed, a certificate to that effect is sent to the owner, after which the boiler may be moved for erection at the purchaser's works. Meantime a general arrangement and setting plan is drawn out by the boiler maker and submitted to the M.S.U.A., and it is sent to the purchaser after revision and approval. This plan shews the arrangement of steam pipes, feed pipes, and blow-off pipes, all of which are important, but particularly the steam pipes, as defective arrangements thereof have caused several explosions. After setting, the boiler is again examined to see that the plan has been followed, and that everything is satisfactory before steam is got up.

At the last annual meeting a resolution was passed expressing confidence in the periodical inspection of steam boilers as a means of preventing explosions, and urging the importance of legislation to this end. An attempt in this direction having failed, it has been thought better to proceed more cautiously, and that it might be well to introduce a measure to secure that insurance be always accompanied by inspection. The practice of the M.S.U.A. is "No inspection—no guarantee," and the practice of boiler insurance companies should be "No inspection—no insurance."

The subject of smoke prevention, now prominently before the public, was considered and extensively experimented upon some years ago by the Association. The experience then gained illustrates an extraordinary

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apathy among steam users upon this question. The Association, after experiments, sent, if required by any member, a trained stoker to educate his firemen in smokeless hand-firing. They met with so little response on the part of boiler owners that the services of the trained stoker were very soon discontinued.

The smoke nuisance can be abated or practically abolished by careful hand-firing, and recommendations with that object are offered, which are —Scattering the coal over one side of the fire only at once, first one side and then the other; fire lightly and regularly, and after each charge admit a little air through the fire door; do not stir fires; fit each door with a ventilating grid. The introduction of air by a split bridge has been found very successful in preventing smoke without reducing economy.

No explosion occurred of any boiler guaranteed by the M.S.U.A. during the year.

In an addendum addressed to steam users residing abroad, who frequently avail themselves of the assistance of the Association, it is urged that the usual practice of simply stipulating in a steam boiler contract that the boiler shall be tested by hydraulic pressure in presence of an inspector of the M.S.U.A. is very unsatisfactory and the result misleading. A request for such a certificate may be made by a boiler maker, and it may be found that the boiler and fittings are not abreast of the most approved practice, and any suggestion as to improvements may be met by the maker insisting that all the M.S.U.A. has to do is to certify the test. Hydraulic testing is useful only as an adjunct, and an examination of the boiler is preferable if only one or the other but not both is to be applied. The Association consider it would be better that steam users residing abroad, and contracting for steam boilers with home makers, communicate direct with the Association, and avail themselves of the special service afforded to members in this country, as explained in the report. J. H.

EXPLOSIONS IN COAL MINES FOR TEN YEARS ENDING 1890.

THERE was issued in November last from the Home Office the following Return, showing, with regard to Coal Mines in the United Kingdom, the number for the last ten years, of fatal explosions of which notice was required to be given, under Section 39 of the Coal Mines Regulation Act of 1872, or under Section 35 of the Coal Mines Regulation Act, 1887, the

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number of lives lost, and, where such information was included in the notice, or otherwise conveyed to the Inspectors, and is still preserved, the approximate hour of the shift when the explosion occurred.

Name of Colliery.	Date of Explosion.	No. of Lives Lost.	Approximate Hour of Shift when Explosion occurred.	Remarks.
SCOTLAND, EAST DISTRICT—*Inspector, Mr J. B. Atkinson.*				
Fernlegare	1880—3 April	1	3rd	*Note.*—This return apparently relates to coal mines only.
Glenclelland	1881—30 Sept.	1	3rd	
Cleland Townhead	,, 19 Dec.	1	3rd	
Bothwell Castle	1882—31 Jan.	1	6th	
Udston	,, 15 May	3	1st	
Cornsilloch	,, 29 Jun.	1	2nd	
Craighead	,, 11 Oct.	1	4th	
Braidhurst	,, 20 Dec.	1	8th	
Kinneil	1883— 9 July	1	1st	
Roughcraig	1884—28 Feb.	1	5th	
Mill	,, 9 Apr.	1	1st	
Bredisholm	,, 10 July	1	2nd	
Rawyards	1885— 9 Jan.	1	6th	
Udston	1887—28 May	73	9 a.m., 2nd	
Devon	,, 15 Jun.	1	2nd	
Morrisonshaven	,, 30 Aug.	3	1st	
Thankerton	,, 24 Nov.	1	8th	
Birkenshaw	1888— 9 Mar.	1	1st	
Broxburn	1882—25 Aug.	4	7th	Shale mines are under the Coal Mines Regulation Act, and at these mines the foregoing explosions occurred.
Pentland	1886— 5 Apr.	1	6th	
Deans	1887— 4 Jun.	1	8th	
Broxburn	,, 7 July	2	7th	
Broxburn	1888—15 Dec.	1	8th	
Kirkland	1889—31 Jan.	1	2nd	
SCOTLAND, WEST DISTRICT—*Inspector, Mr J. M. Ronaldson.*				
Pennyvenie	1880— 4 Feb.	1	Cannot be ascertained	
Gilmilnscroft	,, 18 Jun.	1	8th	
Redburn	,, 16 Aug.	2	1st	
Calderbank	1881—12 Aug.	1	4th	
Knightswood	,, 5 Oct.	2	1st	
Annick Lodge	,, 28 Nov.	1	Cannot be ascertained	
Misk	1882—12 Jan.	1	1st	
Drumpeller	1883— 3 May	1	5th	
Daldowie	,, 27 Jun.	1	3rd	
Ballochmyle	,, 3 Dec.	1	1st	
Balornock	1884—11 July	1	1st	
Heathery Knowe	1885—11 Sept.	1	1st	
Haugh	,, 11 May	1	1st	
Pennyvenie	,, 10 Dec.	1	3rd	
Trabboch	1887—26 May	1	5th	
Haugh	1888—28 Feb.	1	1st	
Bothwell Park	1889—23 July	1	6th	
Lanemark	,, 12 Oct.	1	3rd	
Meiklehill	,, 4 Nov.	2	5th	
Barrwood	,, 20 Dec.	1	9th	
Hallside	1890—4 April.	1	5th	
Gilbertfield	,, 24 Mch.	1	6th	
Broomhouse	,, 6 April.	1	1st	

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NEWCASTLE DISTRICT—*Inspector, Mr James Willis.*

Name of Colliery.	Date of Explosion.	No. of Lives Lost.	Approximate Hour of Shift when Explosion occurred.	Remarks.
Dearham	1879—28 Nov.	1	6th	The hour given in the last column is the hour of the shift of the deceased persons.
South Benwell	1880—16 Nov.	1	2nd	
	1881— —	—	—	
Dearham	1882—25 Mar.	1	3rd	
Whitehaven	,, 25 Apr.	4	1st	
Clifton	,, 27 Sept.	1	1st	
Harrington	1883—31 Mar.	2	5th	
	1884— —	—	—	
Usworth	1885— 2 Mar,	42	4th	*In the St. Helen's Colliery explosion, the hour of the shift cannot be given. Several hours previous to the explosion, a fire had been burning in the workings, and all the men in the pit were engaged, directly or indirectly, in endeavouring to extinguish it, and had been so employed from 5 or 6 hours to as many as 17. The ordinary shifts were thus disarranged.
	1886— —	—	—	
Oatlands	1887—24 Jan.	1	Cannot be ascertained	
South Medomsley	,, 20 Apr.	1	4th	
Oatlands	,, 16 June	1	Cannot be ascertained	
Walker	,, 29 Aug.	1	2nd	
Walker	,, 24 Oct.	8	3rd	
Saint Helen's	1888—19 Apr.	30	—*	
Deekham Hale	,, 2 July	1	4th	
Dipton	1889—21 Mar.	1	4th	
Hebburn	,, 4 Nov.	6	2nd	

DURHAM DISTRICT—*Inspector, Mr Thomas Bell.*

Seaham	1880— 8 Sept.	164	5th	
	1881— —	None	—	
Trimdon Grange	1882—16 Feb.	74	5th	
Sherburn	,, 25 Feb.	1	2nd	
Tudhoe	,, 18 Apr.	37	4th	
West Stanley	,, 19 Apr.	13	3rd	
Cragshall*	,, 5 Oct.	2	10th	*An ironstone mine, but worked under the Coal Mines Regulation Act.
	1883— —	None	—	
	1884— —	None	—	
	1885— —	None	—	
Elemore	1886— 2 Dec.	28	3rd	
	1887— —	None	—	
	1888— —	None	—	
	1889— —	None	—	
	1890— —	None	—	

YORKSHIRE AND LINCOLNSHIRE DISTRICT—*Inspector, Mr F. N. Wardell.*

Allerton Bywater	1880— 3 Feb.	2	4th	
Middleton	,, 5 Apr.	4	8th	
Kiveton Park	,, 19 May	4	2nd	
Aston Main	,, 26 May	1	Cannot be ascertained	
Pildacre	1881—26 Sep.	1	7th	
Sunny Bank	1882—15 Mar.	1	9th	
Bruntcliffe	,, 1 May	7	3rd	
Wharncliffe Carlton	1883—18 Oct.	20	3rd	
St. John's	1884—29 Feb.	1	Cannot be ascertained	
Roundwood	1885—13 Feb.	1	5th	
East Ardsley	,, 4 Aug.	1	8th	
Altofts	1886— 2 Oct.	22	2nd	
Falhouse	,, 5 Nov.	1	4th	
	1887— —	—	—	
Shaw Cross	1888—26 Mar.	1	3rd	
Smithies	,, 27 June	1	Cannot be ascertained	
Newmarket	,, 28 Aug.	2	—	In sinking shaft.
Whitwood	1889—21 Aug.	2	3rd	

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Name of Colliery.	Date of Explosion.	No. of Lives Lost.	Approximate Hour of Shift when Explosion occurred.	Remarks.
MANCHESTER DISTRICT—*Inspector, Mr Joseph Dickinson.*				
New Lester, Tyldesley, Black Seam	1880—23 Apr.	1	4th	
Bradley Fold, Bolton, Gingham Seam	,, 2 Oct.	1	7th (night)	
Shakerley, Tyldesley, Black and White Seam	1881—16 June	1	5th	
Towneley, Burnley, Upper Mountain Seam	,, 18 Nov.	1	6th	
Townley, Burnley, Arley Seam	1882—29 June	1	3d (afternoon)	
Clifton Hall, Manchester Doe Seam	,, 13 Sept.	1	2nd	
Stopes, Bolton, Doe Seam	1883—30 Oct.	4	1st	
Altham, Accrington, Lower Mountain Seam	,, 7 Nov.	68	3rd	
New Watergate, Little Hulton, Black and White Seam	,, 22 Dec.	2	4th	
———	1884— —	None	—	
Clifton Hall, Manchester, Trencherbone Seam	1885—18 June	178	4th	
Outwood, Manchester, Gingham Seam	,, 7 Oct.	1	9th	
Hoddlesden, Darwen, Lower Mountain Seam	,, 26 Oct.	1	1st	
Cupola, Burnley, Arley Seam	1886—15 July	1	6th	
Bedford, Leigh, Crumbouke Seam	,, 13 Aug.	38	5th	
———	1887— —	None	—	
———	1888— —	None	—	
———	1889— —	None	—	
IRELAND.				
———	1880 to 1889 inclusive	None	—	
LIVERPOOL DISTRICT—*Inspector, Mr Henry Hall.*				
Wrexham, Wrexham	1880—15 Jan.	1	1st	
Bersham, Wrexham	,, 3 Aug.	9	8th	
Hay Hall, Wrexham	1881— 8 May.	2	7th	
Tawd Vale, Skelmersdale	,, 23 Sep.	1	6th	
Park Lane, Wigan	,, 29 Sep.	2	4th	Shotlighters.
Tawd Vale, Skelmersdale	,, 22 Oct.	1	6th	
Abram, Wigan	,, 19 Dec.	48	6th	
Sutton Heath, St. Helen's	,, 28 Dec.	1	1st	
Phœnix, St. Helen's	1882—16 Feb.	1	2nd	
Maes-y-greg, Mold	,, 6 Nov.	2	1st	Firemen.
Maires, Wigan	1883—27 Feb.	2	5th	
Sandycroft, Mold	,, 9 Mar.	1	6th	
Mostyn, Mostyn	1884—22 July	1	1st	
Bettisfield, Bagillt	,, 2 Oct.	2	8th	
White Moss, Skelmersdale	,, 12 Nov.	1	7th	
Strangeways Hall, Wigan	1885—20 Feb.	2	3rd	Shotlighters.
Sutton Heath, St. Helen's	,, 2 Apr.	1	1st	
Taylor, Wigan	,, 29 Dec.	1	—	Putting out a fire, which had been caused by a shot 20 hours previously.
Bradley Hall, Wigan	1886—15 Dec.	1	9th	Special shift.
Brynn, Wigan	1887—26 May	3	3rd	Shotlighters.
Ffrwd, Wrexham	,, 28 Nov.	3	4th	
Lea Green, St. Helen's	1888— 4 May	3	9th	
Brynmally, Wrexham	1889—13 Mar.	20	8th	

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MIDLAND DISTRICT—*Inspector, Mr A. H. Stokes.*

Name of Colliery.	Date of Explosion.	No. of Lives Lost.	Approximate Hour of Shift when Explosion occurred.	Remarks.
———	1880— —	None	—	
Pleasley, Mansfield, Notts	1881—16 Apr.	1	4th	
Hartington Pit, Staveley, Derbyshire	,, 2 Sept.	1	1st	
Whitwick, Coalville, Leicestershire	,, 22 Sept.	1	6th	
Charity, Bedworth, Warwickshire	,, 18 Oct.	1	1st	
Bailey Brook, Butterley, Derbyshire	1882— 9 Jan.	1	9th	
Baddesley, Atherstone, Warwickshire	,, 2 May	23	3rd	
Marebay, Ripley, Derbyshire	,, 15 Sept.	1	5th	
Clay Cross, No. 7, Desbyshire	,, 7 Nov.	45	4th	
Brinsley, Eastwood, Notts	1883—10 June	2	1st	
Manners, Ilkeston, Derbyshire	1884—29 Nov.	1	3rd	
———	1885— —	None	—	
Reservoir, Moira, Leicestershire	1886— 8 Dec.	2	9th	
Mapperley, Ilkeston, Derbyshire	1887— 2 Apr.	1	5th	
———	1888— —	None	—	
———	1889— —	None	—	

NORTH STAFFORDSHIRE DISTRICT—*Inspector, Mr W. N. Atkinson.*

Madeley and Leycett	1880—21 Jan.	62	3rd	
Lillydale	,, 30 July	1	5th	
Shelton, No. 2 Racecourse Pit	,, 24 Dec.	2	2nd	
Whitfield	1881— 7 Feb.	25	3rd	
Lillydale	,, 3 May	8	5th	
Shelton, Deep Pit	,, 21 Nov.	4	* 6th and 12th	
Bradley Green	,, 22 Dec.	1	4th	
Silverdale, Hollywood Pit	1882— Aug.	2	4th	
Shelton, Deep Pit	1883— 2 Sep.	3	5th	
Madeley and Leycett	,, 21 Oct.	6	* 10th and 6th	*Men commencing work at different times were in the pit when the explosion occurred.
Silverdale, No. 6 Pit	1884—14 May	2	8th	
Priors Lee, Dark Lane Pit	,, 4 Sep.	2	5th	
Priors Lee, Lawn Pit	,, 8 Oct.	1	5th	
Great Fenton	1885— 8 Apr.	8	2nd	
Apedale	,, 20 June	9	4th	
Lilleshall	,, 17 Sep.	1	2nd	
Donnington, Grange Pits	1887—24 Apr.	3	9th	
Apedale	,, 26 Aug.	1	4th	
Hyde	1889—18 Jan.	23	4th	
Chell	,, 17 Aug.	3	† 15th	†The under-manager and three firemen remained in the pit to remove an accumulation of gas after the workmen had left.
Mossfields	,, 16 Oct.	64	7th	

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Name of Colliery.	Date of Explosion.	No. of Lives Lost.	Approximate Hour of Shift when Explosion occurred.	Remarks.
South Staffordshire District—*Inspector, Mr W. B. Scott.*				
Cop Hall	1880—10 Jan.	1	1st	
Essington Wood	,, 23 Jan.	1	Not known	Gas fired by powder shots.
Black Lake	,, 7 June	1	2 p.m.	When reversing air current.
Saltwells	,, 30 Aug.	1	6.30 a.m.	Before shift, when examining.
West Cannock	1881—20 Mar.	1	6th	Two shots fired in quick succession.
Eight Locks	,, 26 May	1	8th	Gas released by "bump."
Golds Green	,, 6 Sept.	1	7th	Night.
Hange	,, 17 Oct.	2	Not known	Gas in unknown old workings.
Fair Oak	,, 22 Nov.	1	4th	
Mounts	1882—30 June	1	1st	Ironstone.
Cradley Heath	1883— 9 June	1	1st	
Wednesbury Oak	,, 21 Nov.	1	1st	
Aldridge	1884— 2 Jan.	1	1st	
Cannock Chase	,, 9 Feb.	1	3rd	
Sandwell Park	,, 17 Mar.	1	6th	
Grace Mary	,, 28 Mar.	1	4th	Fall of coal liberated gas
Ebenezer	,, 23 July	3	7th	Night.
Tividale Hall	,, 24 July	1	3rd	In a sinking shaft.
Hall End	,, 6 Sept.	7	2nd	Night shift and continuous.
Black Lake	1885—16 Nov.	2	1st	
Sandwell Park	1886— 2 Dec.	1	1st	
Fishley	,, 10 Dec.	1	3rd	A surveyor.
Aldridge	1887—23 Feb.	1	1st	
Gospel Oak	,, 31 Aug.	2	4th	
Essington Farm	1888—28 Feb.	1	3rd	In a sinking shaft.
Lanehead Bridge	,, 25 Oct.	1	3rd	
Dairy Farm	1889—27 June	1	3rd	
Ashmore Park	,, 25 Oct.	1	5th	
Saltwells	,, 31 Oct.	2	7th	
South-Western District—*Inspector, Mr J. S. Martin.*				
Tredegar Iron and Coal	1880—10 Mar.	6	5th	
London and South Wales	,, 15 July	120	4th	
	1881— —	None	—	
London and South Wales	1882—15 Jan.	4	—	Shot firing when men ordinarily employed were out of mine.
John Lancaster and Co.	,, 27 Feb.	5	2nd	
Tredegar Iron and Coal	,, 1 Dec.	2	4th	
Coalbrook Vale	1883—12 Mar.	1	6th	
Rhymney Iron	,, 25 June	6	6th	
Tranch	,, 24 Aug.	1	1st	Entered a place fenced off.
Patent Nut and Bolt	,, 3 Dec.	1	2nd	
Bedminster	1884—12 Feb.	1	3rd	
Bedminster	,, 4 Nov.	1	1st	
Tredegar Iron and Coal	,, 8 Nov.	14	5th	
Leonard Boult	1885—28 Aug.	1	1st	
Powell Duffryn, S. C.	,, 1 Oct.	2	8th	
Leonard Boult	1886—19 Feb.	8	1st	
Edford	,, 22 Feb.	2	2nd	
Bedminster	,, 9 Sep.	1	2nd	
Bedminster	,, 10 Sep.	10	8th	
Lancaster, Speir and Co.	,, 6 Dec.	1	1st	
Bristol Collieries	1887—27 May	1	9th	
	1888— —	None	—	
Bedminster	1889—28 Jan.	4	1st	
Patent Nut and Bolt	,, 9 July	1	8th	
Ebbw Vale	1890—22 Jan.	5	5th	
Partridge Jones	,, 6 Feb.	176	2nd	

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SOUTH WALES DISTRICT—*Inspector, Mr J. T. Robson.*

Name of Colliery.	Date of Explosion.	No. of Lives Lost.	Approximate Hour of Shift when Explosion occurred.	Remarks.
River Level Pit, Aberdare,	1880—8 June	1	Not recorded	
Grangoch,	,, 7 July	6	Not recorded	
Naval Steam Coal	,, 10 Dec.	101	7th	
Penydarren	1881—16 July	1	Not recorded	
Bargoed Longwork	,, 29 Aug.	1	Not recorded	
Vochrhiw, No. 1	,, 29 Sept.	1	Not recorded	
Lewis, Merthyr	1882—11 Feb.	4	Not recorded	
River Level Pit, Aberdare,	,, 3 May	1	Not recorded	
Yniswen	,, 9 May	1	Not recorded	
Llwynypia, No. 3 Coal	,, 2 Oct.	1	Not recorded	
Seven Sisters	,, 30 Oct.	1	Not recorded	
Gelli Steam Coal	1883—21 Aug.	5	Not recorded	
Gwaun Cae Gurwen	,, 13 Sep.	1	Not recorded	
Aberdare, Rhondda	,, 11 Nov.	1	Not recorded	
Llan	,, 24 Nov.	1	Not recorded	
Pontyberem,	,, 27 Nov.	1	Not recorded	
Naval Steam Coal	1884—27 Jan.	14	1st	
Mountain	,, 10 Mch.	1	Not recorded	
Parkslip	,, 3 April	2	Not recorded	
Brynhenllys	,, 12 Jne.	1	Not recorded	
Transatlantic	,, 18 Dec.	3	1st	
Vochrhiw	1885—24 Jan.	1	Not recorded	
Aberdare	,, 17 Feb.	1	Not recorded	
Cwm, Merthyr	,, 19 Oct.	1	Not recorded	
No. 9, Maesteg	,, 21 Dec.	1	1st	
Mardy	,, 23 Dec.	81	9th	
River Level Pit	1886—8 Jany.	1	Not recorded	
Werfa	,, 26 Mch.	4	Not recorded	
Glyn	,, 28 Aug.	1	1st	
Glyn	,, 30 Aug.	1	Not recorded	
Bonville's Court	,, 16 Sept.	1	Not recorded	
Trimsaran	,, 19 Nov.	3	5th	
Cribbwr Main	1887—20 Jan.	1	Not recorded	
National	,, 18 Feb.	39	1st	
Abercanaid	1888—9 April	1	1st	
Aber	,, 14 May	5	1st	
Seven Sisters	,, 25 Jne.	1	1st	
Tynybedw	,, 25 Sept.	1	7th	
Llanmorlais	1889—25 Feb.	2	8th	

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The JOURNAL of the IRON and STEEL INSTITUTE.

ON THE PROPOSED CHANNEL BRIDGE.

By Messrs SCHNEIDER & Co. and H. HERSENT. No. II., 1889, p. 40.

THE object of this paper is to show that the construction of a bridge between France and England may now be considered capable of realisation in practice. The technical details and estimates have been worked out in conjunction with Sir John Fowler and Sir B. Baker, engineers of the Forth Bridge. The material proposed to be used is, of course, steel, of which about a million tons will be required. The longest spans to be 500 metres (555 yards) in length, supported by columns resting at different depths on the bottom of the sea. The estimated cost is 34¼ million pounds, and the time required for the completion of the undertaking is set down at ten years.

The line of the bridge is across the narrowest and shallowest part of the straits, taking advantage of the banks of Colbart and Varne which lie in mid-channel, and over which, at low water, there is a depth of only four fathoms. On the British side of the banks the depth does not exceed sixteen fathoms, but on the French side a depth of thirty fathoms is attained, so that here the greatest difficulty in laying the foundation will be encountered.

From repeated experiments it is found that the resistance of the white and blue chalk, that forms the bottom, is such as to secure the stability of extensive works, and it is considered capable of supporting a load of ten tons per square foot (ten to twelve kilos per square centimetre). The piers will consist of masonry, set with Portland cement, laid on the sea bottom, and having a batter of 1 in 10 up to the top of the foundation caisson. The surface of these piers above high water measures 650 square metres, and serves as the foundation for the metal columns which carry the girders. Up to a certain height the masonry will cover the whole surface of the base, but higher up pockets or hollows will be formed in order to decrease the load upon the ground. The masonry will be built in metal caissons, which will be sunk by the pneumatic process, after being floated out to the spot where they are to be grounded. They will be surmounted by a moveable dome to afford protection from the sea while the pier is being finished above the level of low water. The whole of the piers will occupy about one-twelfth of the section of the channel, but this reduction of area is not considered likely to lead to erosion of the sea bottom between them. The minimum clearance at high water across the whole length of the girders will be 180 feet, amply sufficient for the passage of the largest vessels.

The metal columns placed on the piers vary from 133 to 142 feet in height, and carry the main girders of the bridge, which, in order to consult the exigencies of navigation and carry out economically the preparatory works, are proposed to be in three different lengths, viz.—

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alternating spans of 300 and 500 metres, alternating spans of 200 and 350 metres, and alternating spans of 100 and 250 metres—the longest spans corresponding to the greatest depths, and the shortest to the shallower places and vicinity of the shores.

The bridge is to carry two lines of rails, at a height of 240 feet above low water, and although it would be easy to establish a bridge with four lines, the development of traffic did not appear to warrant the increased outlay necessary. The girders proposed are simple unlatticed beams. The two main side girders slope and meet in a point at the top like the legs of the letter A, the permanent way being carried at the position of the cross-bar of the letter. The width of the bridge is variable, the greatest distance between the axes of the main girders being 83 feet, which is necessary, to resist the violent gusts of wind.

A detailed description is given of the foundation works, including the construction, conveyance, and fitting into position of the piers, and of the materials and machinery required.

The calculations regarding the superstructure were undertaken by J. B. Pradel, and the construction, transport, and erection of the metal spans are described, including the machinery employed in fitting up. Estimates of weight and calculations of the resistances for the different members of the large spans are given in detail.

J. G.

The JOURNAL of the IRON and STEEL INSTITUTE.

ON GASEOUS FUEL.

By Sir LOWTHIAN BELL. No. II. 1899, p. 139.

GENERALLY when power is once generated the sooner it is applied the better. A steam engine stores up its work in a hydraulic accumulator and a sacrifice of energy is made for the purpose of obtaining a power far beyond what could be got by the direct application of the engine. In the same way part of the energy of coal may be used for its conversion into the gaseous form so as to obtain a temperature of greater intensity than could be got from the direct combustion of the coal, for the purpose of doing certain kinds of work, and the sacrifice may be in like manner justifiable. The purpose of the author is to show that broadly and generally nothing can be gained in a calorific point of view by the gasification of fuel.

Dealing with producer gas he takes a specimen of coal having a composition of 70 fixed carbon, 16 coal gas, and 14 ash, oxygen, and nitrogen. This will produce 16 coal gas, 163·3 carbonic oxide, and 222 nitrogen.

By the combustion of the coal the following heat-units will be developed :—

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		Calories.
100 coal × 7,200 calories,...		= 720,000
By the combustion of the gas—		
16 olefiant gas × 10,000 calories, ...	= 160,000	
163·3 carbonic oxide × 2,400 calories, ...	= 391,920	551,920
Being a loss of		168,080

or nearly 23·3 per cent. of the whole.

The change in producing water gas is expressed by :—

$$H_2O + C = H_2 + CO.$$

The heat required to dissociate a unit weight of H from its oxygen is 34,200 calories; the burning of a unit weight of carbon only evolves 2,400 calories, so that 14¼ units of carbon are required to dissociate a unit of hydrogen. In the equation there are only 6 units of carbon for one of hydrogen, so that it is easy to understand how the incandescent carbon in the producer is speedily cooled below the temperature required for the decomposition of water. When air is again introduced to raise the temperature, producer gas only is given off. Of the carbon it is assumed 25 parts by weight enter the water gas and 75 parts are converted into producer gas.

From the 25 parts of carbon there is generated 62·5 parts of water-gas containing 4·16 parts of hydrogen and 58·34 carbonic oxide. The producer gas from the 75 parts of carbon weighs 551·19, of which 376·19 is nitrogen and 175 carbonic oxide. The heat of combustion of these two gases is :—

		Calories.
Water gas, 4·16 H from steam	× 29,400	= 122,304
58·34 CO	× 2,400	= 140,016
Producer-gas, 175 CO	× 2,400	= 420,000
		682,320
The direct combustion of the carbon would yield 100 × 8000		= 800,000

Hence the loss by gasification is equal to 14·68 per cent.

In a Moravian work, in producing 36 million feet of gas, each metre of water gas was accompanied by 4·92 metres of producer gas. Assuming the composition of the coal to be as before in each metre of water gas there would be :—

500 litres H = 44·8 grammes.
500 „ CO = 625·0 „ = carbon 267·8

The producer gas consists of—

370 litres coal gas =	206·83 grammes.		
1140 „ CO	= 1805·19	„	= carbon 773·6
3110 „ N	= 3921·23		
4920	5933·25		1041·4

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The heat units in the carbon is	1041·4	× 8000	= 8,331,200
„ „ the coal gas is	206·83	× 10,000	= 2,068,300
			10 399,500

The heat units in the water and producer gas is—

Water gas, H from steam,	44·8	× 29,400	= 1,317,120
„ CO	625	× 2,400	= 1,500,000
Producer gas, Coal gas,	206·88	× 10,000	= 2,068,300
„ „ CO,	1805·19	× 2,400	= 4,332,456
„ „ N,	3921·23		
			9,218,376

Showing a loss of 11·36 per cent. in gasifying the coal.

The results are summarised by comparing the calories yielded by burning coal in an ordinary furnace (1) with the calories in the producer gas that would be supplied from it to an open hearth steel furnace, and (2) with the heat units that would be delivered by the water gas and producer gas got from the same coal. For 100 units of fuel burnt, there is afforded by coal, 89·93 ; ordinary producer gas, 71·14 ; water gas and its producer gas, 78·80.

For general use, the author is of opinion, solid coal is not likely to be superseded by any form of factitious gaseous fuel.

J. G.

The JOURNAL of the FRANKLIN INSTITUTE.

ELECTRIC RAILWAYS.

By EUGENE GRIFFIN. Vol. CXXIX., p. 265.

THIS is a lecture delivered before the Institute really on electrical tramways for cities and towns. One of the great advantages in the use of electricity is that the generating station may be placed outside the town, where ground is cheap, or by a river side where condensing water can be got, or in a situation where fuel may be cheaply delivered, as the loss in transmission is inconsiderable. Street car work imposes very variable and sudden loads on the engines and dynamos, so that a considerable margin of power is required. For this kind of work the Thomson-Houston Company is now building dynamos of 250 H.P. It is stated that 500 volts has been universally adopted as the maximum pressure for railway purposes, and is considered within the limits of safety.

The motors in general use have series wound Siemens armatures, and

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give a test efficiency as high as 91½ per cent. They are usually placed under the cars, although in that position they are exposed to the water, mud, sand, and dust of the streets. The trolley-arm and trolley-wheel for making contact with the overhead wire carrying the current are considered, and the author doubts whether any form of open slot conduit carrying the wire underground can be devised to meet the conditions under which tramways are operated. He thinks where there are junctions, cross-overs, and switches, the system of double wires forming a complete overhead circuit is not feasible, so that the system to be adopted is the single wire overhead, with a return current going through the rails, each joint of which is bridged by a tie wire.

J. G.

The JOURNAL of the FRANKLIN INSTITUTE.

"WATER RAM" IN PIPES.

By IRVING P. CHURCH. Vol. cxxix., p. 328.

THE increased internal pressure in a pipe containing flowing water, due to the more or less sudden stoppage of the flow by the closing of a valve, is what is known as "water ram"; and it is noticed here that it seems customary among authorities in hydraulic engineering to make a rough allowance for this source of danger in pipes, "with but scanty show of rational basis for the rule given." The danger depends on the maximum pressure, and it is clear that this depends on the rate at which the valve is closed, and on whether the rate of closing is uniform or variable, so that the mathematical investigation of the subject, which is the purpose of the paper, is not a very simple one.

The investigation is not concluded, but the case of a long level pipe with its inlet just below reservoir level, and with a given velocity at the instant the valve gate begins to close at its lower end, which discharges into the air, is considered on the assumption that the closing is uniform: that is, that there are equal reductions of area of orifice occurring in equal times. In the result, where the pipe was 10,000 feet long, initial velocity of the water 6 feet per second, and the whole time of closing 10 minutes, it appears that the reduction of velocity is very slow during the first half of the time of closing, and is very rapid towards the end.

J. G.

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TRANSACTIONS of the AMERICAN INSTITUTE of MINING ENGINEERS.

THE ENGLISH Versus THE CONTINENTAL SYSTEM OF JIGGING: IS CLOSE SIZING ADVANTAGEOUS?

By H. S. MUNRO. Feb., 1889.

THE paper is a study of the action of the jig, and a description of experiments undertaken in order to develop the laws which underlie the process.

In the English system the crushed ore, coarse and fine together, is first jigged on a hand sieve with coarse mesh, and the fine stuff, somewhat concentrated by passing through the bed of coarse mineral grains on the sieve, is again jigged on a sieve of finer mesh. In machine jigging a bed of mineral is maintained on the sieve, and the concentration is mostly effected by jigging through this bed.

The Continental or German system starts with a sizing by screens, after which the different sizes are treated on separate jigs.

The laws regulating the descent of spheres in water are discussed, but it has long been recognised that the conditions which obtain in jigging are not the same as in the case of bodies falling freely in water. In practice numbers of grains move together, the smaller grains passing in the interspaces between the larger grains, and consequently in constricted channels; and with the object of determining the laws governing the movement of bodies in confined channels a series of experiments was made with lead shot of different diameters. The shot were suspended in a tube and subjected to rising currents of water at different velocities. The buoyant effect of the current was measured by means of a spring balance. It was found that the lifting effect on the sphere is not proportional to the square of the velocity of the rising current in the tube, but that it is nearly proportional to the square of the velocity in the annular space between the shot and the walls of the tube. In the case of free falling spheres the resistance has been found by various experimenters to be proportional to about one-half the sectional area of the sphere, but these experiments show this only holds good for the case of small spheres falling in large tubes, and as the diameter of the shot approaches the diameter of the tube the resistance is proportional more nearly to the full sectional area. It was found that the sphere having the maximum falling velocity in any tube is the one whose diameter is four-tenths that of the tube. Spheres of larger or smaller diameter fall more slowly. Shot moving *en masse* fell with one-sixth of the velocity of free falling spheres. Experiments were made with rounded and angular ore grains, with large spheres surrounded by small spheres, and with spheres of mixed diameters, and also with spheres in irregular interstitial channels.

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The author gives the following *resumé* of the main points developed in his investigation :—

1.—Bodies falling through water in a tube do not attain as high a velocity as in falling through the same medium in large vessels.

2.—The falling velocity is but little affected when the diameter of the body is less than one-tenth that of the tube.

3.—The falling velocity is the more retarded as the diameter of the body approximates that of the tube.

4.—A sphere four-tenths the size of the tube will develope the greatest falling velocity, and will require a current of maximum velocity to support or raise it.

5.—Grains falling *en masse* are really moving in confined channels, and follow the law of the movement of bodies in tubes. The falling velocity, and the velocity of the current necessary to support or raise the mass of grains, increase and diminish with the distance apart of the grains.

6.—The diameter of the channel in which the single grain moves equals the cube root of the volume of the grain with its proportion of the interstitial space, or, in other words, the cube root of the space occupied by the grain.

7.—In a mass of grains of different sizes, the large grains move relatively in smaller channels than the small grains. The diameters of equal falling grains of quartz and galena, under such conditions, is 31 to 1, instead of 4 to 1, which latter ratio holds good for free falling grains only.

8.—The formulæ for grains moving in tubes, when applied, as above, to grains moving *en masse*, enable us to compute the velocity of jig-currents, and thus determine the proper length and number of strokes of the jig-piston. The old formulæ gave results many times too large.

9.—*The present investigation demonstrates that close sizing is not necessary for the separation of different minerals by jigging, unless the difference in specific gravity is small.* This has been recognised in practice for some time, especially in this country.

10.—Downward currents are apparently necessary to success in jigging through a bed. This requires confirmation by experiments on a larger scale.

11.—Very fine material, less than one-tenth millimeter in diameter, can be treated successfully on jigs, *if treated with coarse stuff*—the concentration taking place in the small interstitial channels between the grains forming the mineral bed. *For the treatment of fine stuff on jigs, close sizing is a positive disadvantage.* Jigs work well on mixed stuff, and very badly on fine stuff alone. Stuff less than four-tenths the size of the smallest interstitial channels cannot be treated successfully in this way.

12.—The size of the mesh of the jig sieve has a very important influence and must be proportioned to the work to be done.

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13.—The English method of jigging without sizing, except possibly so far as is necessary to remove the very finest slimes, has many advantages, and should be more generally adopted. J. G.

TRANSACTIONS of the AMERICAN INSTITUTE of MINING ENGINEERS.

NOTES ON FUEL GAS.

By GEORGE W. GOETZ. Feb., 1890.

IN a ten days' experiment with Pittsburg coal of the following average composition :—

Water, ...	1·26 per cent.
Volatile matter, ...	36·22 „
Fixed carbon, ...	57·98 „
Sulphur, ...	0·70 „
Ash, ...	3·78 „

it was found that a ton of coal gave on an average 131,280 cubic feet of producer gas, which shewed on analysis :—

CO_2, ...	3·4 per cent.
CH_4, ...	3·1 „
H, ...	9·2 „
C_2H_4, ...	0·8 „
CO_2, ...	25·3 „

the remainder being mainly nitrogen.

When coal is used, the ordinary single-handed puddling furnaces of Pittsburg consume about 36,000,000 British heat units per gross ton of pig iron, whereas when gas is employed about 14,000,000 heat units suffice. To puddle a ton of pig iron required 13,250 cubic feet of natural gas, containing 1,100,000 heat units per 1000 cubic feet, or 47,000 cubic feet of a gas containing 300,000 units per 1000 feet; and when using a gas containing only 266,000 heat units it was found that 54,000 cubic feet were required to puddle a gross ton of pig iron. J G.

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Papers read at the MINING CONFERENCE at DUNEDIN, March, 1890.

PRESENT POSITION AND FUTURE PROSPECTS OF THE MINING INDUSTRY.

By JAMES ALLAN, B.A.

IN the thirty-six years ending with 1888. the value of minerals produced in New Zealand was upwards of £52,000,000, five-sixths of this sum being from gold and silver and about one-twentieth from coal. The production of gold has been marked by a gradual decrease since 1866, when the value of the year's work was £2,844.517, whereas in 1889 the value amounted to only £808,549. The output of coal, on the contrary, shows a steady but moderate increase. In 1885 the output was 511,063 tons, and in 1888, 613.895 tons. The estimated available quantity of coal in the colony is 1,200,000.000 tons, of which 500,000,000 tons are brown coal or lignite, an equal quantity of pitch coal, and the remainder bituminous coal of excellent quality. Iron ore has not been worked to any considerable extent, but large deposits of good ore are known to exist, with limestone and coal for smelting in close proximity.

ROPE HAULAGE AT COALBROOKEDALE COLLIERY.

By THOMAS J. WATERS.

THE coal from the colliery is lowered through a vertical height of 1700 feet in a distance of a mile and a quarter by two self-acting inclines—one at an inclination of 1 in 1⅛ and the other at 1 in 2⅛. The load on the rope is one truck weighing when full 11 tons, and carrying 6½ tons of coal. The novel feature in the arrangement is a cataract brake. The drum shaft is fitted with a crank at each end, which are connected by a rod, one to each of two pistons, 12 inches in diameter, working in horizontal cylinders. The motion of the pistons, and through them the velocity of the drum, is controlled by regulating the flow of water from one side of the pistons to the other on the principle of the cataract. The temperature of the water is prevented from rising too high by withdrawing a portion of it at each stroke, and introducing fresh water to supply its place.

The underground haulage is by endless rope, with hutches attached singly to the rope which passes underneath the hutches. There is a novel method of applying the chain attachment in use, described as follows :—"It consists of a short length of chain, on one end of which is a welded ring, and on the other a hook. At each hanging-on place a pair of light steel springs are bolted to a cross sleeper. These springs lie parallel to the rope, and the loose ends are made to fit and embrace it when pressed together. The hanger-on passes the chain three times round these springs where they embrace the rope, which slips between them as it runs without imparting any motion to the chain clip ; hence the hanger-on is enabled to pass the hook end through the ring on the chain and make it fast to

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the truck at his leisure. At the proper time the truck is pushed forward a few inches by hand, when the chain clip slips off the steel springs and holds fast to the travelling rope, drawing the truck with it. These chain clips have now been in use for two years, and continue to give every satisfaction, holding on our steepest grades and passing round all curves with ease and smoothness." The steepest gradient is 1 in 5. This attachment with hanging-on spring has been patented in England, the Colonies, and the United States. J. H.

INSTITUTION of MECHANICAL ENGINEERS. Proceedings 1890.

ON RECENT IMPROVEMENTS IN THE MECHANICAL ENGINEERING OF COLLIERIES.

By EMERSON BAINBRIDGE. P. 360.

MANY of the improvements here described have been already noticed in these "Notes," and others cannot, even by the widest interpretation of the term, be called "recent." The trouble of travelling pumps in a sinking shaft has been avoided in a new winning in Yorkshire by using a new pump devised by a Salford firm. It is suspended in the shaft by capstan ropes. The pump consists of a vertical steam cylinder, with two hollow plungers attached one on each side. The plungers are enclosed in two sliding barrels passing in the one piece downwards into one pipe of about double the diameter, which forms another hollow plunger with valve at the top. These barrels are connected to the piston of the steam cylinder above. The barrel into which the lower plunger works has a suction valve at the bottom of it, and is connected to the steam cylinder by tie bolts. The pump acts thus: As the piston and lower plunger rise the water follows the latter through the suction valve into the lower barrel, while at the same time the water in the two upper barrels is forced up the rising main. On the down stroke the water in the lower barrel is in turn forced through the delivery valve into the upper barrels and thence to the rising main. Six of these pumps have been put into two sinking shafts near Doncaster. Together they are capable of raising 5000 gallons of water per minute through a height of 300 feet.

Steel rail guides in shafts at Nunnery Colliery are considered not successful. Counterbalancing in winding does not appear to be much considered in fitting up winding plants. Scroll drums seem presently the favourite device, but their great weight in a measure counteracts their effect. One of these at Ynysybwl Colliery varies in diameter from 18 feet to 33 feet, and coal is drawn therewith from a depth of 500 yards in 35 seconds. At a colliery in Derbyshire, 170 yards deep, the speed of winding and changing is such that three cage loads are raised per minute.

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At Nunnery Colliery a Priestman oil engine is pumping 40 gallons of water per minute through 1700 yards of pipe and a vertical height of 400 feet. The quantity of oil used is from 1¼ to 1½ pints per actual horse power per hour. In another case the cost for labour and petroleum is 1¾d per horse power per hour. To minimise the danger from fire the rising main is connected with four of Grimmell's sprinklers in the engine room, which act if the temperature reaches 155 deg. Fah.

Springs are in use at Nunnery Colliery to reduce the shock of the cages landing in the pit bottom. Four spiral springs are used to each cage, and at the landing they yield about two inches, the compression diminishing by half as the cage rests, and increasing again to two inches as the load is placed on the cage. These springs also decrease the strain at the commencement of the winding.

Elliot's lubricator for hutch axles consists of a layer of felt within a cap of steel. The felt is said to be capable of absorbing sufficient oil to last for three months.

DESCRIPTION OF THE LOOMIS PROCESS OF MAKING GAS FOR FUEL.

By R. N. OAKMAN, Jun. P. 402.

THIS process recently introduced into the Sheffield district produces three kinds of gas—producer gas, water gas for fuel, and carburetted water gas for lighting. The two former, which are alone dealt with, are produced alternately in the same generator, which in appearance is like an ordinary gas producer. The fuel is introduced by a door in the top of a circular chamber, through which air is also admitted. The gas given off by the fresh charge is drawn by an exhauster down through the hot fuel beneath and through a discharge opening at the bottom of the chamber. Thence it passes up through the flues of a vertical boiler, which generates steam for the water gas, and is delivered into a gas holder. This goes on till the new charge becomes incandescent, after from four to six minutes, when the exhauster is stopped and the connection therewith closed by a valve. Steam is then introduced at the bottom, and passes up through the incandescent fuel, and the water gas generated discharges through a washer into a gas holder. Thus generator gas and water gas are produced alternately over periods of four to six minutes each. But this alternation is not necessary, as the apparatus can act continuously as a common gas producer. The generators have been worked daily for over six months without requiring the fires to be drawn or broken up. When the generator is worked to produce the maximum quantity of water gas per ton of coal, the producer gas obtained in addition to the water gas is equal in heating power to more than half the coal consumed. The water gas obtained has a peculiar and strong odour, and has a lighting power of four to ten candles, due to the presence of hydrocarbons from the bituminous coal used. The water gas thus obtained is said to have a

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higher calorific power than that produced by using either anthracite coal or coke. The quantity of water gas produced per ton of coal is from 35,000 to 45,000 cubic feet. The advantage of the process lies in the production of the two kinds of gas—producer gas, to be used in re-heating, annealing, and boiler firing, where more moderate temperatures are required, and water gas for purposes demanding intense heat. J. H.

THE MANCHESTER STEAM USERS' ASSOCIATION.

Report on a Series of Red Hot Furnace Crown Experiments

To ascertain the Result of Injecting the Feed Water into a Boiler when short of Water and with Fires Burning.

By L. E. Fletcher, Chief Engineer.

It has long been the popular belief that nearly every boiler explosion which has occurred in this country has been occasioned by the boiler being allowed to run short of water, and by the sudden introduction of the cold feed water into the over-heated boiler, causing such an instantaneous increase of pressure within it as to burst it. Many eminent scientific men have held this opinion. Captain Pringle, R.E., and Mr Josiah Parkes, M. Inst. C.E., who were appointed by the Committee of the Privy Council to investigate accidents of this description, in referring to the explosion on the steamship "Union" at Hull, on 7th June, 1837, by which 24 persons were killed, state :—"It is attributed to the instantaneous disengagement of an immense volume of steam produced by the oscillation or listing of the vessel, the boiler being at the time short of water, and the upper plates of the furnace on the higher side of the vessel being probably red hot or nearly so ; no ordinary number of safety valves could have liberated the amount of steam generated when the wave of water caused by the oscillation passed over the red hot plates."

Mr J. Scott Russell, C.E., the well-known builder of the "Great Eastern," says :—"When the water in a boiler gets too low and the plates become red hot, the action of the pump raises the water on to the red hot metal, and steam is generated so rapidly that an explosion almost inevitably ensues." The celebrated engineers, Messrs Maudsley & Field, of Lambeth, London, endorsed this view. Mr James Oldham, C.E., Hull, took the same view of the cause of the "Union" explosion as the engineers referred to above ; and similar opinions were entertained at that time by other scientific men. The Manchester Steam Users' Association considers the views given above to be erroneous, and though

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they may have been modified by the scientific men who first enunciated them, they took deep root in the public mind, and have continued to be generally entertained to the present day. The question was submitted to several engineers of experience, but though they were fully aware that the specific heat of iron compared with water was so low that no large volume of steam would be generated, they all hesitated to give an opinion as to what would be the behaviour of the furnace crowns under such treatment, and could suggest no other method of solving the problem than that of instituting a practical trial.

On the matter being brought before the Committee of the Association, it was resolved to have the experiment tried on a practical scale, and that a full-sized mill boiler should be laid down for the purpose. A piece of open ground on the premises of the late Mr Joseph Clayton, Preston, and adjoining his boiler shop, was selected for the site, and the boiler, which was of the ordinary Lancashire type, 27 feet 9 inches long, 7 feet diameter in the shell, with 2 furnace tubes, each 3 feet in diameter; the thickness of the plates—$\frac{7}{16}$ inch in the shell, $\frac{9}{16}$ inch in the ends, and $\frac{7}{16}$ in the furnace tubes, all of iron throughout, the ends both back and front being strengthened with 4 gusset stays above the furnace tubes and with 2 at the front end and 1 at the back end, below. The firegrates measured 6 feet in length, by 3 in width, giving 18 square feet of grate surface in each furnace. The boiler was set in the usual way on two longitudinal side walls, the flames, after leaving the internal flue tubes, passing under the boiler, and then, lastly, along the sides. The feed pipes were so arranged that the water could be fed into the boiler in the ordinary way, or it could be showered directly on right hand or left hand furnace crown, as desired, or on both at the same time, by the experimental feed pipes. Gauge glasses were fixed so as to show the level of the water in the boiler, from 16 inches above the furnace crowns to 16 inches below them. Two safety valves were fitted on the boiler—one of external pendulous dead-weight construction, 3 inches in diameter; the other the ordinary box-lever construction, 4 inches diameter. The chimney used was 72 feet high, and of ample area, and usually produced a draught in the furnaces equal to $\frac{1}{2}$ inch water guage. The feed pump was a 5-inch plunger, with a stroke of 12 inches, capable of feeding upwards of 5 cubic feet of water per minute, equal to the evaporation of three or four similar boilers under ordinary circumstances, so that the conditions would be similar to those which would arise in practice, supposing one boiler in a range of three or four to become short of water, and then have the feed supply of the entire range turned into it. Every precaution was taken in the way of erecting barricades, &c., to prevent accidents to persons outside the works, and a strongly protected observatory was erected 33 feet from one side of the boiler for the protection of the observers, into which connections from all parts of the boiler were carried, and arrangements made so that the observers could watch

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the behaviour of the furnace crowns, and see how they hogged and flattened as they were heated and cooled, and ascertain the level of the water in the boiler and the pressure of the steam as it rose and fell; they could also inject the feed or lower the water, and lay bare the furnace crowns at pleasure, while in addition they could ease the safety valves and reduce the pressure without leaving the observatory. As the boiler was laid down for experimental purposes, advantage was taken of the opportunity to ascertain the effect of the fire on the water in the boiler with regard to its rate of heating at the top as compared with the bottom, and also to ascertain the effect of the fire on the boiler in producing movements both in the shell and furnace tubes. The result of the experiment showed that the temperature of the water at the bottom of the boiler rises very slowly in comparison to the rate of increase at the top: thus after 68 minutes' firing the temperature of the water above the tubes rose from 83° to 290°, a difference of 215°, while the water below the tubes rose from 78° to 103°, a difference of only 25°, and at this stage of the experiment there was a difference between the temperature of the water above the tubes and that below the tubes of 195°. Subsequent experiments on this important subject confirm the above, and they have also demonstrated that cross tubes in the flues have little effect in diminishing this startling difference of temperature that may exist in a boiler. It was found that when the steam had been raised to 50lbs. per square inch the shell of the boiler had lengthened $\frac{3}{8}$ of an inch, but there had been little motion vertically, at the same time the internal flue tubes had hogged upwards of $\frac{1}{2}$in. about mid length. When these preliminary observations had been made, the experiments for ascertaining the effect of showering cold water on the red hot furnace crowns were proceeded with.

Experiment No. 1.—In this experiment the feed water was injected at atmospheric pressure, instead of under steam pressure as in subsequent trials. The blow-out tap was opened, and the water brought down to the level of the furnace crowns, the blow-out tap was then shut. The fires were then worked up into good condition, the safety valves being kept open. The blow-out tap was then opened full bore for twenty minutes, when the water was brought down 16 inches below the level of the furnace crowns and about 2 inches above the level of the fire bars. After a further interval of five minutes, the dead weight safety valve was closed, but by oversight the lever safety valve was left open. At this moment the feed was showered on to both furnace crowns immediately over the fire by the two experimental feed pipes, the temperature of the feed water being 62° fah., and the rate of injection about 5½ cubic feet per minute. On this being done, the pressure of steam in the boiler rose from 6lbs. to 12lbs. in 1¼ minutes. The injection of the feed was kept on continuously, and in 1¾ minutes the pressure fell down to 1lb.

Experiment No. 1a.—As the lever safety valve had been inadvertently left open, it was decided to repeat the experiment, and the fires were

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therefore worked up again. After the boiler had been emptied to 16 inches below the crowns, with the fires burning clear and bright, about 7 inches thick, and the dampers full open, the feed was turned on as in Experiment No. 1, the pressure in the boiler began to rise, in ¾ of a minute it rose from 6lbs. to 27lbs., after which it gradually fell ; the feed was kept on, and in 13½ minutes the pressure was again reduced to 6lbs., and in 20 minutes the water was brought up again to the level of the furnace crowns, pressure of steam 4lbs. The boiler was so thoroughly heated at this test that two blisters, one 20 by 9 inches, and the other 10 by 6 inches, were developed on the crown of the left hand furnace, some of the ring seams of rivets were sprung, and one of the tubes at the back end of the furnace measured 3 feet 1¼ inches horizontally by 2 feet 9¾ inches vertically, showing the tube to be 3½ inches oval. No other damage was done. The four crown plates were taken out, re-rolled to restore their circular shape, replaced, and rivetted up afresh, the boiler tested by hydraulic pressure to 100lbs. on the inch, and found all right.

Experiment No. 2.—The safety valves were adjusted to blow off at 40lbs. With the steam blowing off at this pressure, the fires burning briskly, and the dampers wide open, the blow-out tap was opened full bore, and the water level reduced to 15 inches below the crowns. At this point the blow-out tap was shut and the fires allowed to go on burning with the furnace crowns bare. In six minutes after the water had been brought down to its lowest level, a slight downward indication of the crown of the right hand furnace was observed. The instant this was noticed the feed was turned on, but the valve was scarcely opened before the right hand furnace tube collapsed and rent at the first ring seam over the fire, forming an opening about 3 feet circumferentially by 12 inches wide at the middle. Through this opening, the steam and water rushed with great violence. No other damage was done to the boiler, except a slight bulging down of the left furnace tube of about 1 inch at the crown. It will be seen from this experiment that a furnace crown when overheated may collapse with little or no prior warning ; that the collapse when it begins is but the work of an instant, and that to stand before a furnace in order to draw the fires when shortness of water has occurred, relying on the gradual movement of the crown to give warning, is a very hazardous undertaking.

Experiments No. 3 and No. 3a were conducted under the conditions likely to occur in ordinary work. The water was reduced to the level of the crowns and the firing continued—in the one case for five minutes, in the other for ten minutes—and then the feed turned on, with the result in each case that no increase of pressure took place, nor any damage to the boiler.

Experiments No. 4 and No. 4a.—Conditions similar to No. 3 and No. 3a, except that the time of firing was increased to fifteen minutes before the feed was turned on. There was no increase of pressure, on the contrary, it fell in seven minutes from 25lbs. to 20lbs.

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Experiments No. 5, No. 5a, No. 5b, No. 5c.—Although still further extended in time of firing, with greater areas of the crowns bare, they gave similar results to the previous experiments; there was no increase of pressure on the introduction of the feed, nor any damage of consequence to the boiler.

Experiment No. 6.—In this, still more severe tests than any of the foregoing were made, but with the same results. There was no increase of pressure, nor any serious damage to the boiler.

Experiment No. 7.—This experiment was conducted with more than usual care. The fires in the boiler had been kept burning for two days, so that the flues might be warm and the draught good. When both safety valves began to blow off at 25 lbs. per square inch, the blow-off tap was opened and the water lowered to the level of the crowns, when it was shut. The fires were then recharged after this, though the water was beginning to leave the furnace crowns. This being done, the observers withdrew from the front of the boiler, leaving the fires, nine inches thick, burning briskly, with the dampers full open. The pressure of the steam by this time had risen to 29½lbs., and both safety valves were blowing off fiercely. Eighteen minutes after the water had left the level of the furnace crowns, the falling of one of the counterbalance weights in the observatory indicated that the lead plug on the left furnace had melted. In other three minutes another counterbalance weight indicated that the tin plug on the left furnace had melted. Two and a half minutes later, the zinc disc on the right furnace melted. On this being observed, the feed was at once showered on the right furnace crown. The water level at the time was 3⅝ iuches below the crown, laying bare a strip of the crown 21 inches wide. Results.—No increase of pressure, on the contrary the pressure at once began to fall, and 2½ minutes had fallen from 28½lbs. to 26lbs. Two minutes later, the falling of another counterbalance weight in the observatory indicated that the zinc disc on the left furnace had melted. An examination of the boiler after these experiments showed that the ring seams in each furnace were sprung at the crowns and leaking, but that otherwise the boiler did not seem to be much damaged.

These experiments clearly put to rout the generally received opinion that showering cold water on red-hot furnace crowns would cause the "instantaneous disengagement of an immense volume of steam, which would act like gunpowder," overpowering the safety valves, however efficient, tearing the outer shell of the boiler to pieces, and hurling the fragments to a great distances; yet these opinions have been repeated again and again. It is trusted that these experiments will be of public service by helping to correct some of the mistaken views too generally entertained with regard to the cause of steam boiler explosions. J. P.

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TO

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IN

THE TRANSACTIONS

OF THE

MINING INSTITUTE

OF SCOTLAND.

VOLS. I.—XII.

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